May 18, 1959

Aviation Week

Including Space Technology

SPECIAL REPORT:

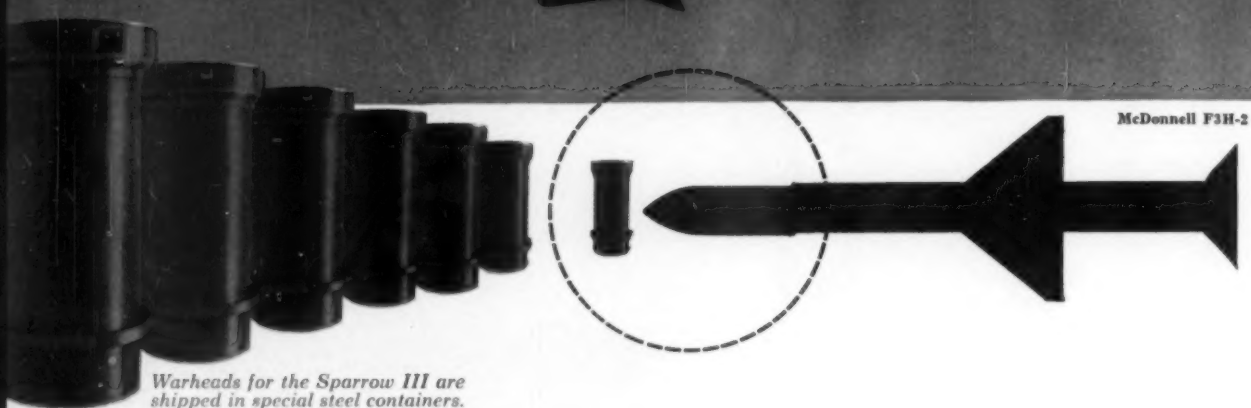
Space Technology Laboratories

North American A3J-1 Vigilante

TALONS FOR THE SPARROW

Rheem produces warhead for Navy's lethal air-to-air missile

McDonnell F3H-2 Demon



Warheads for the Sparrow III are shipped in special steel containers.

On guard along the nation's advance lines of defense are high-performance U. S. Navy aircraft armed with the Navy's foremost air-to-air missile, the Sparrow III.

First successful quantity production of Sparrow III warheads was achieved after Rheem engineers solved the difficult fabrication problems posed by the new type of warhead recently developed by the Naval Ordnance Laboratory.

This important production project for the U. S. Navy Bureau of Ordnance is typical of the pioneering work being carried on from development through production for all branches of the Armed Services by Rheem Ordnance. Further example of Rheem's capability in producing complete warhead systems is current work under way on related missile ordnance, such as fuzes and safety-and-arming devices.

To investigate the full Rheem capability for warhead system development or production, and associated work in the broad field of ordnance, write to Dept. AW-710-1.

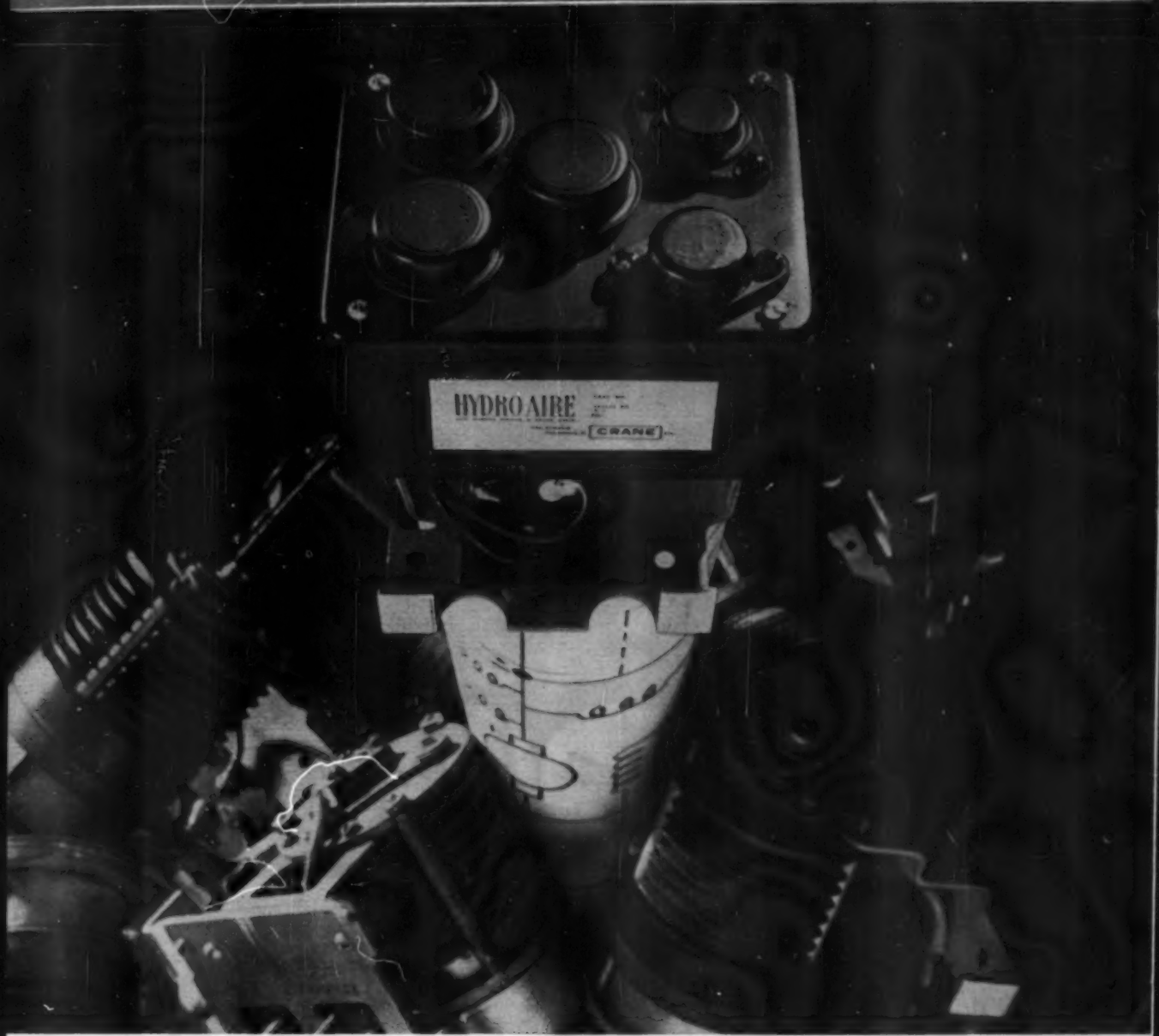
RHEEM MANUFACTURING COMPANY

Defense and Technical Products Division

11711 woodruff avenue, downey, california

Rheem

ORDNANCE • ELECTRONICS • DRONES • PROPULSION & MISSILE SYSTEMS • PRESSURE VESSELS • RESEARCH



When d-c generator regulation troubles pile up...

Specify Hydro-Aire's new transistorized voltage regulator

Hydro-Aire's new, completely transistorized regulator for d-c generators weighs less than half as much as the conventional carbon-pile regulator that it replaces. Response time is five times better, and operational life is extended to 10,000 hours. The new Hydro-Aire units are physically and functionally interchangeable with MIL-standard carbon-pile regulators – plug directly into existing receptacles.

Other important features of the new Hydro-Aire unit: Has no moving parts, requires no shock mounting, dissipates virtually no heat, requires no forced cooling, adjusts easily to different voltages.

Model 50-029 (shown above) has these characteristics:

Voltage: may be set to any value between 26 and 30 volts, in increments of 0.1 volt.
Temperature limits: −55°C to +71°C
Rated life: 5000 hours without maintenance
Dimensions: 3¼ x 4⅛ x 2⅞ inches
Weight: 1¼ pounds

Additional ratings are available and our laboratories welcome the opportunity to design new devices to your specific requirements.

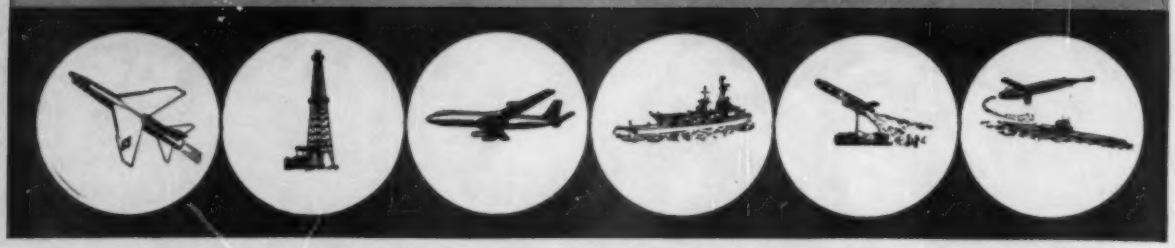
Write or wire for complete information on Hydro-Aire's generator regulators, and other solid-state devices.

Producing Controls for Every Basic Airborne System

HYDRO-AIRE
BURBANK, CALIFORNIA
Division of CRANE CO.
Solid-State Power Supplies · Frequency Converters · Amplifiers · Electric Motors · Solenoids · Actuators · A.C. Voltage Regulators · Generator-Regulators

SARGENT

SERVO-SYSTEMS OF FORCE CONTROL



With 38 years acceptance Sargent builds precision linear and rotary hydraulic, pneumatic, mechanical and electronic systems of force control to meet successfully the increasingly high requirements of marine, aircraft, missile, petroleum and industrial use. From original idea to finished product – SARGENT.

SARGENT FACILITIES including –

- Research
- Design
- Development
- Testing
- Qualifying
- Manufacturing
- Machining & Grinding
- Heat Treating, all types
- Plating, all types
- Inspection
- Assembly

SARGENT BUILDS

- Servo-Systems
- Hydraulic Systems
- Integrated Packages
- Hydraulic Actuators
- Hydraulic Valves
- Hydraulic Pumps
- Hydraulic Motors
- Pneumatic Cylinders
- Pneumatic Valves
- Ball Screw Actuators
- Gear Actuators
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Standard of Excellence — *Since 1920*

Sargent — QUALITY BUILDS GOOD WILL

ENGINEERING CORPORATION

MAIN OFFICE & PLANT, 2533 E. FIFTY-SIXTH ST.
HUNTINGTON PARK, CALIF.

"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court

AVIATION CALENDAR

May 24-June 5—Federation Aeronautique Internationale Annual Meeting, Moscow, USSR.

May 25-27—1959 National Telemetering Conference on Investigation of Space, Brown Palace and Cosmopolitan Hotel, Denver, Colo. Sponsors: American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and Instrument Society of America.

May 25-27—All Industry Production and Quality Control Exposition and Convention, American Society for Quality Control, Cleveland Public Hall and Hotel Sheraton, Cleveland, Ohio.

May 25-28—Design Engineering Show and Conference, American Society of Mechanical Engineers, Convention Hall, Philadelphia, Pa.

May 29-31—Soaring Society of America's Northeastern Soaring Meet, Dutchess County Airport, Poughkeepsie, N. Y.

June 1-3—Third Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, University Heights, Bronx, N. Y.

June 1-3—National Symposium, Institute of Radio Engineers' Professional Groups on Microwave Theory & Techniques, Harvard University, Cambridge, Mass.

June 3-5—13th National Convention, Armed Forces Communications and Electronics Assn., Sheraton-Park Hotel, Washington, D. C.

June 4-5—Third National Conference, Institute of Radio Engineers' Professional Group on Production Techniques, Villa Hotel, San Mateo, Calif.

June 5-6—Annual Meeting of the Army Aviation Assn. of America, Shoreham Hotel, Washington, D. C.

June 5-6—10th Annual Maintenance & Operations Meeting, Reading Aviation Serv-

(*Continued on page 6*)

AVIATION WEEK Including Space Technology

May 18, 1959

Vol. 70, No. 20

Published weekly with an additional issue in December by McGraw-Hill Publishing Company. James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Publication Offices, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary. Officers of the Publications Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice President; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.
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QUARTECTOR*

LIQUID LEVEL DETECTION SYSTEMS

for liquid oxygen and rocket fuels

- **No moving parts assure unsurpassed reliability**
- **Will not respond to wetting or splashing**

IN-TANK SENSOR

ELECTRONIC UNIT

Explosion-proof version for ground installation

IN-LINE PROBE

Quartector Liquid Level Detection Systems, with no moving parts to stick or freeze, detect liquid levels to within ± 1/32" with a response time of less than 40 milliseconds. Operating temperature range is from −425°F to +120°F.

Quartector systems and instruments are designed for *bulk liquid applications* such as fuel tanks in missiles or other types of pressure vessels, and for *pumping applications.* A real-time indication is provided when the liquid has reached pre-selected points in pipe lines or tanks.

The Quartector sensing element is a piezo-electric quartz crystal mounted in a probe or submersible sensor unit. Circuitry consists of a four stage transistor amplifier with a transistor detector circuit in the feedback loop, and an output control relay. When the crystal is in gas, it is free to vibrate at its natural frequency, and oscillation is sustained. When the crystal is submersed in liquid, however, its motion is damped, signal output drops, and the output control relay is de-energized.

Splashing, bubbles, and wetting do not affect the sensor. Liquid indication is given only when the crystal is completely surrounded by liquid. Safety features include a fail-safe and function test procedure. Write to Trans-Sonics, Inc., Dept. 7, Burlington, Massachusetts, for Technical Bulletin 1900.

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Precision Transducers

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HADLEY

missile valves & controls

Leakage problems?

If your enthusiasm is somewhat dampened by leakage trouble, why not let Hadley design engineers help you with your system problems. In addition to sound engineering, Hadley laboratories are equipped for all types of environmental testing. Supported by precision manufacturing and rigid quality control, Hadley is able to deliver the quality product on schedule.

For more information write,
J. T. Reilly, Director of Marketing

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AVIATION CALENDAR

(*Continued from page 5*)

ice, Inc., Municipal Airport, Reading, Pa.

June 8-11—Semiannual Meeting and Astronautical Exhibition, American Rocket Society, El Cortez Hotel, San Diego, Calif.

June 12-21—23rd French International Air Show, Le Bourget, Paris, France.

June 13-23—International Conference on Information Processing, UNESCO House, Paris, France.

June 14-18—Semiannual Meeting, American Society of Mechanical Engineers, Chase-Park Plaza Hotel, St. Louis, Mo.

June 16-17—Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, Mich. Sponsor: Michigan Aeronautics and Space Assn.

June 16-19—National Summer Meeting, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

June 21-26—Summer-Pacific General Meeting and Air Transportation Conference, American Institute of Electrical Engineers, Olympia Hotel, Seattle, Wash.

June 23-25—33rd Meeting, Aviation Distributors and Manufacturers Assn., St. Francis Hotel, San Francisco, Calif.

June 24-26—Second National Symposium, Nuclear Industry Division, Instrument Society of America, Idaho Falls, Idaho.

June 29-July 1—Third National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D. C. Sponsor: Institute of Radio Engineers' Professional Group on Military Electronics.

June 29-July 3—Summer seminar on Plastics—Its Mechanical Properties, Design and Applications, Pennsylvania State University, University Park, Pa.

July 1-10—U. S. National Soaring Competition, Harris Hill, Elmira, N. Y.

July 4-8—All-Woman Transcontinental Air Race from Lawrence, Mass., to Spokane, Wash. For information: All-Woman Transcontinental Air Race, Inc., 2611 East Spring St., Long Beach 6, Calif.

July 16-17—Third biennial Joint Meeting, Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

July 30-31—Sixth Annual Symposium on Computers and Data Processing, Denver Research Institute, Stanley Hotel, Estes Park, Colo.

Aug. 4-5—Second Annual Western Regional Meeting, American Astronautical Society, Ambassador Hotel, Los Angeles, Calif.

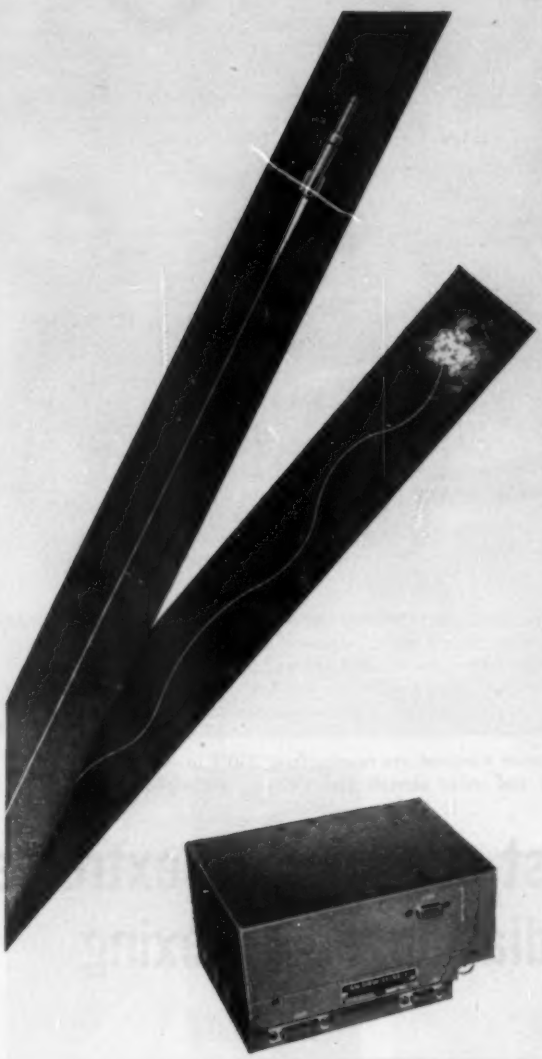
Aug. 5-7—William Frederick Durand Centennial Conference on the problems of hypersonic and space flight, Stanford University, Stanford, Calif.

Aug. 18-21—Western Electronic Show & Convention, Institute of Radio Engineers, Cow Palace, San Francisco, Calif.

Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.



COMMAND DESTRUCT

The flight testing of second generation missiles—more versatile and powerful than their predecessors—requires a device for sure termination of any missile flight that might endanger the test range or surrounding area.

Ramo-Wooldridge engineers, under a United States Army Signal Corps contract, have successfully developed and delivered the first sub-miniature, completely transistorized radio "command destruct" receivers.

Specifically designed for missile flight safety operations, the receiver (AN/DRW-11) can actuate safety mechanisms or destruct devices. It has three command channels, each of which actuates a control relay.

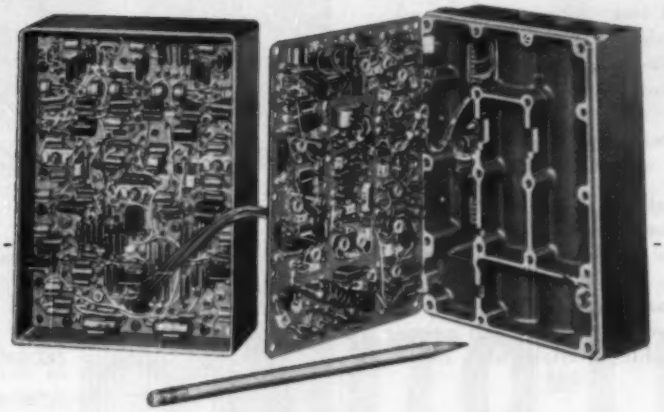
The "command destruct" receiver accepts frequency modulated signals in the UHF radio command control band. It is designed to operate with closer radio frequency and command frequency channel spacing than has been used to date, thus making possible more efficient use of the available radio spectrum.

Compact and rugged, the radio receiver's modular construction permits rapid and complete accessibility to all components. One module houses the basic receiver. The second module contains the three command channels and relays. This integrated package occupies 115 cubic inches, and weighs 4 pounds. The receiver requires no pressurization and operates reliably under the adverse environmental conditions encountered in missile flight testing.

Engineers and scientists interested in being associated with some of the nation's most advanced research and development programs are invited to acquaint themselves with current opportunities at Ramo-Wooldridge. The areas of activity listed below are those in which R-W is now engaged and in which openings exist.

Missile electronics systems
Advanced radio and wireline communications
Information processing systems
Electronic language translation
Anti-submarine warfare
Air navigation and traffic control
Analog and digital computers
Infrared systems
Electronic reconnaissance and countermeasures
Basic and applied physical research

For a copy of our brochure, *An Introduction to Ramo-Wooldridge*, or other additional information write to Mr. Donald L. Pyke.



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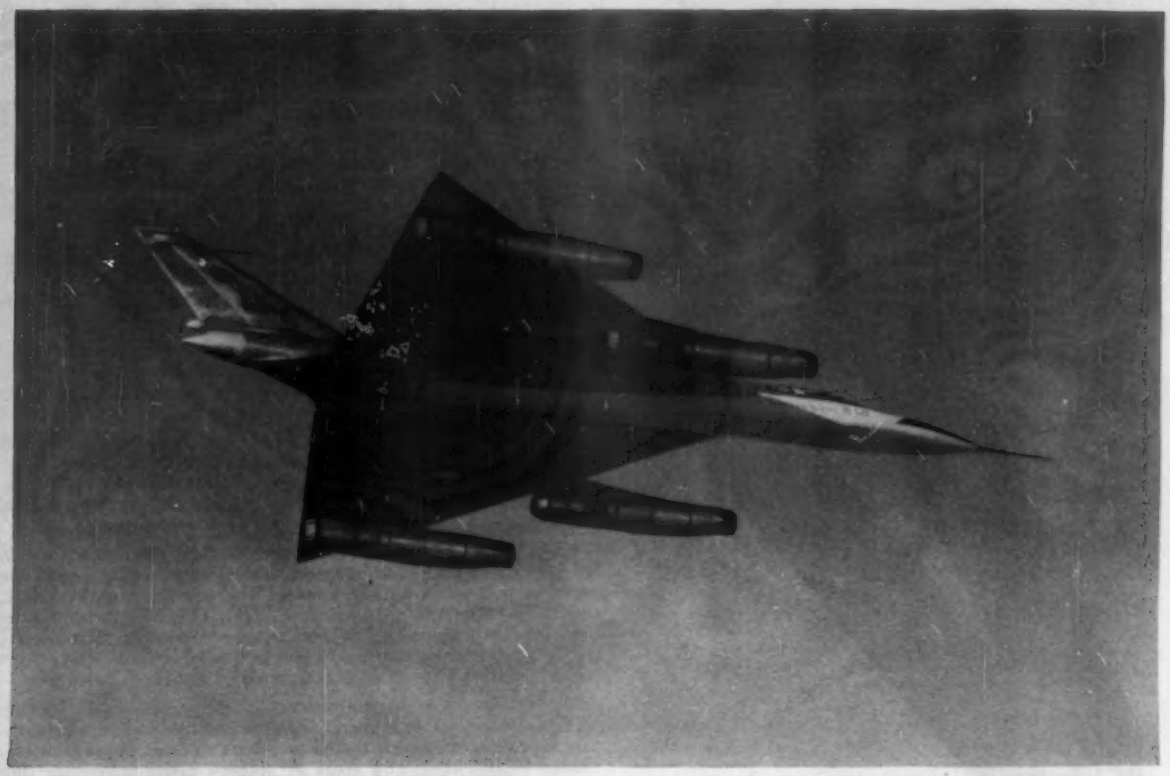
a division of ***Thompson Ramo Wooldridge Inc.***

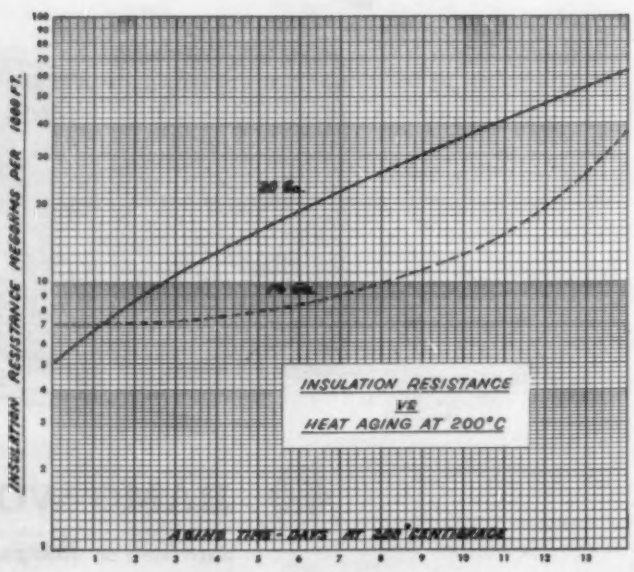


CONVAIR B-58 subjects wire components to normal operation temperatures ranging from 350°F to –65°F. New silicone-insulated wire more than meets these and other aircraft and missile requirements.

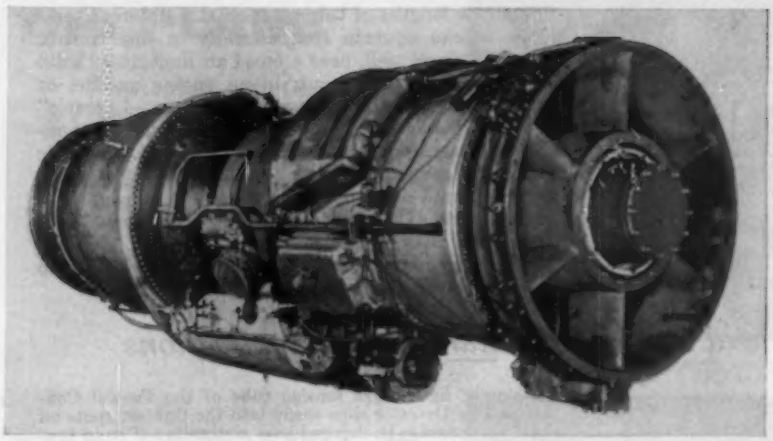
Silicone wire provides best answers for extreme heat, cold, corona, radiation, cold flexing

Looking beyond normal conductor changes and developments, Auto-Lite engineers are constantly developing and improving materials and processes for wire insulation. New materials include silicones, tetra-fluoroethylene, fluorinated ethylene propylene, polyvinyl chloride, nylon, and improved organic elastomers. These materials are providing excellent solutions to today's wire problems.

Silicone-rubber insulation is an outstanding example of these materials. Silicones have opened an entirely new field in the manufacture of wire and cable. The unique properties of the silicone compounds make it possible to have flexible insulated wire operating through a temperature range impossible to attain with other synthetic elastomers.


INSULATION RESISTANCE MEGOHMS PER 1000 FT.
INSULATION RESISTANCE
VS
HEAT AGING AT 200°C
AGING TIME - DAYS AT 200° CENTIGRADE

Graph shows a substantial improvement in Insulation Resistance values after heat aging of silicone-insulated wires. Tests were run on specimens having a glass overbraid saturated with high-temperature lacquer. Also, dielectric strength of silicone compounds remains relatively stable through a temperature range of 25° to 250°C.



HEAT AGING FROM EXPOSURE TO EXTREME TEMPERATURES quickly renders most common organic insulation materials ineffective. The usual heat-resistant materials—mica, asbestos, etc.—because of their lack of flexibility and poor moisture resistance, are difficult to maintain. Silicone-rubber compounds are now available which give excellent performance in continuous operation at temperatures to 500°F.

ANOTHER PROBLEM is the normal operation of aircraft at temperatures down to –80°F. Here plastic and rubber insulations freeze to a glass-like hardness and flake off, especially under severe conditions of vibration. Tests with new materials, again silicones, give outstanding results down to –130°F, far beyond what would ever be encountered in aircraft.

AT HIGH ALTITUDES, silicones are highly effective because of their resistance to the deteriorating effects of corona and arcing. Corona resistance approaches that of mica. In addition to high arc resistance, silicone insulation forms no carbon path regardless of the temperature.

AMERICA'S FOREMOST WIRE RESEARCH LABORATORY is operated by the Auto-Lite General Products Group at Port Huron, Michigan. Here, space-age wire problems have already become routine. This laboratory has the distinction of being completely equipped to perform all qualification tests on wire for military specifications. The facilities and personnel of this laboratory are available to serve all Auto-Lite wire customers.

Where better to direct your aircraft wire problems than to the leader in the aircraft wire field? Auto-Lite has a vast fund of answers to common problems and an outstanding ability to solve the remainder. Write, stating your problems, to . . .

AUTO-LITE®

GENERAL PRODUCTS GROUP

WIRE AND CABLE DIVISION • TOLEDO 1, OHIO

Plants at: Port Huron, Michigan, and Hazleton, Pennsylvania

You Call the Tune...

the Fenwal Continuous Fire and Overheat Detector has hundreds of applications

You can actually bend a Fenwal Continuous Fire Detector System to your needs as easily as a snake charmer handles his pet! *It's as supple as a snake!*

Proved applications of this advanced multi-point protection system are practically everywhere in aircraft and missiles — for hot gas leaks, anti-icing systems, and, of course, for engine protection. *That's versatility!*

Separate lengths of tubing, each at a different temperature, can operate *independently* in one control loop: in a wheel well, near a bleed air duct, in a "solid pack" cargo compartment, in an engine nacelle, or wherever temperature hazards exist. Rugged "static" sensor and magnetic amplifier provide *discrete* non-averaging sensing of temperatures. *And this positive protection is repeatable!*

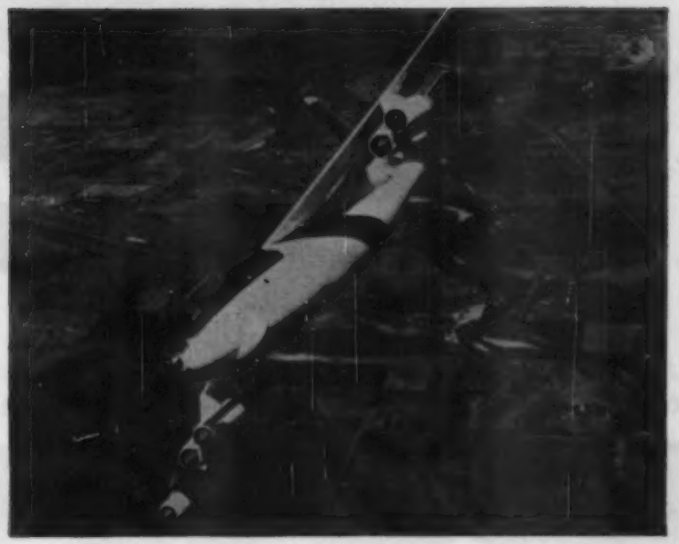
You'll think of many applications for Fenwal Continuous Fire and Overheat Detector Systems. Talk them over with a Fenwal Sales Engineer. Get our latest Catalog, too. Write Fenwal Incorporated, 125 Pleasant Street, Ashland, Massachusetts.

The simple, lightweight sensing tube of the Fenwal Continuous Fire Detector slips easily into the tightest spots on a plane or missile. It strings like a clothesline. Ties in to a light, no-moving-parts control unit.

ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

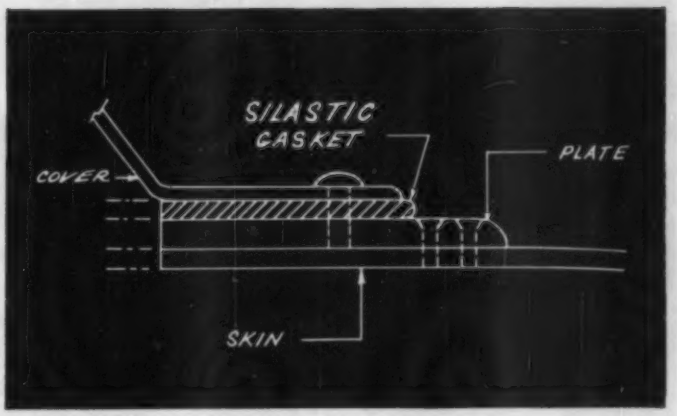
The PLANE

Strategic Air Command's Boeing B47E Stratojet. This six-jet medium bomber is believed to be the first aircraft of its size capable of toss-bombing. The B47 has a speed of over 600 mph, a normal range of more than 3000 miles, and carries nuclear stores.



The PROBLEM

Forming a firm seal between the B47's antenna cover and the fuselage. The gasket employed must be a resilient material, must resist the biting cold slipstream, and must not compress out of functional shape. Retention of resiliency is of prime importance.



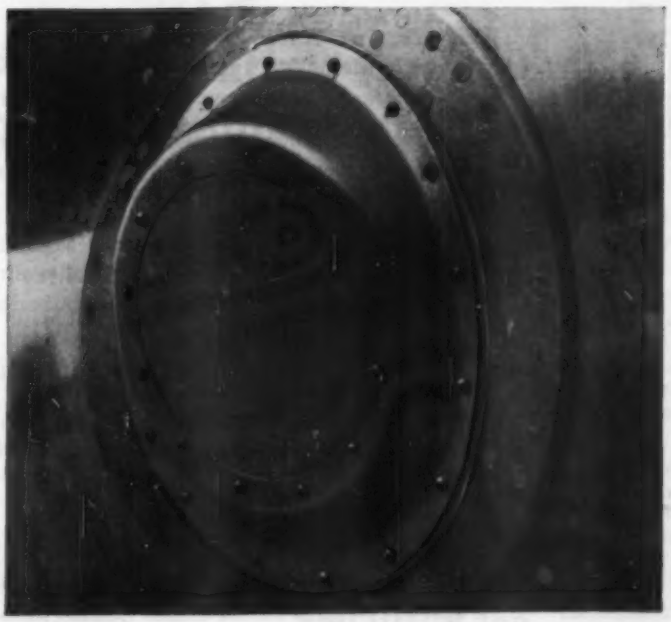
The PART ----SILASTIC

Gaskets of Silastic® the Dow Corning silicone rubber proved supremely successful. Silastic is also used for many other parts on the B47E.

TYPICAL PROPERTIES OF SILASTIC FOR GASKETS

Temperature range, F	—130 to 500
Tensile strength, psi	600 to 1400
Tear strength lb/in	40 to 200
Compression set, %, @ 300 F	5 to 40

For further information, write Dept. 0917.



first in silicones

Dow Corning
CORPORATION
MIDLAND, MICHIGAN

3=1

3 thoroughly competent departments—Research, Engineering and Manufacturing—equal one complete systems capability. The Mechanical Division of General Mills is your single source for technical problem-solving!

Left—*Dr. John Barkley*, Director of Research, heads the department that moves from hypotheses to facts, clarifying the present, probing the future, recording findings for comparison and evaluation.

Center—*Dr. Howard Baller*, Director of Engineering. His department gives substance to ideas, showing *how* these ideas can be converted into practical military and industrial products.

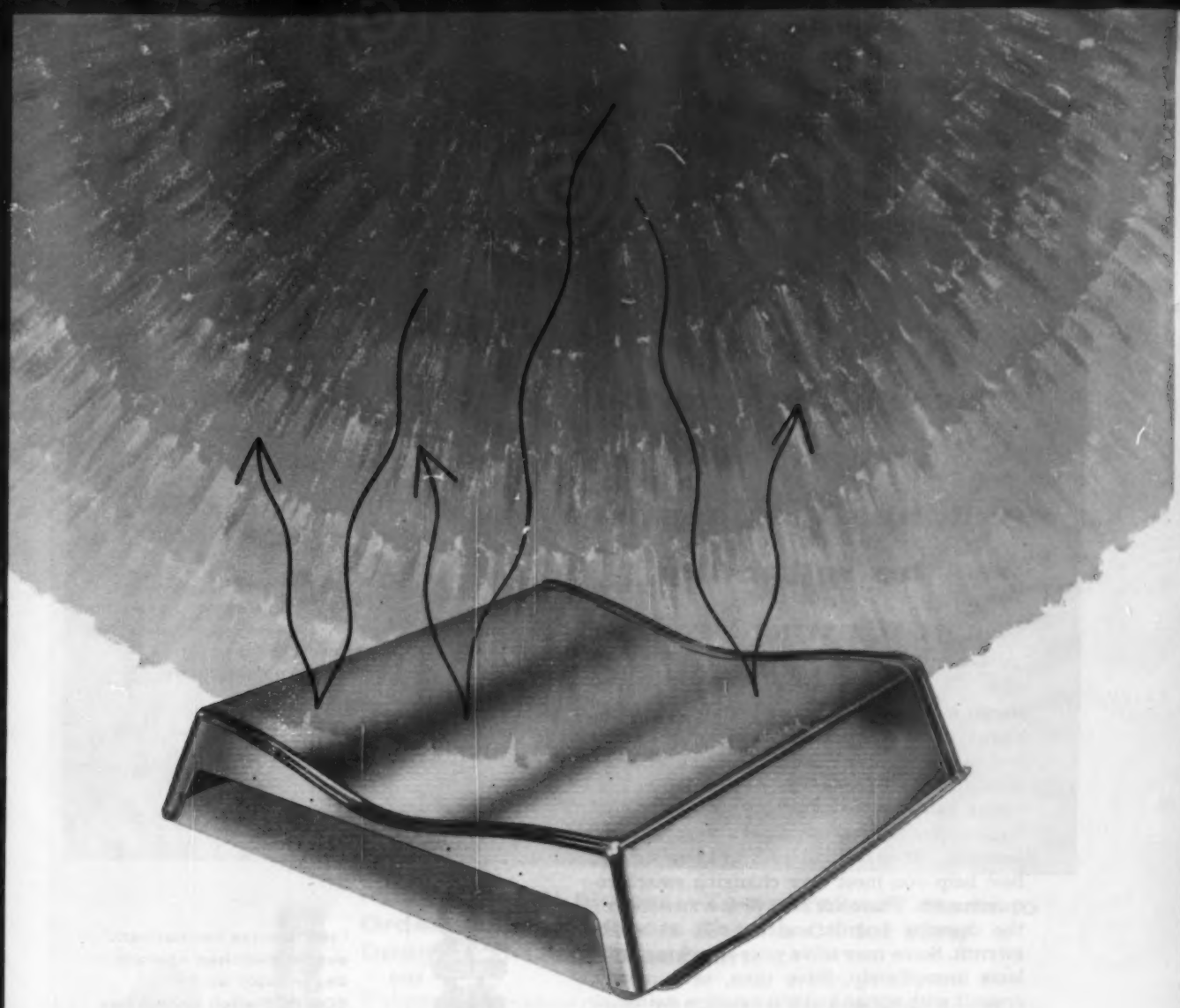
Right—*Kenneth J. Carlson*, Director of Manufacturing, and his men transform theories and designs into physical realities, utilizing the skills of all three departments to meet every production requirement—*on schedule!*

Mechanical Division teamwork plays a vital role in *all* our current activities, including: *Search and Track Systems* (infrared optics, visual optics, radar, antennas, slave platforms) *Guidance and Navigation Systems* (computers, and inertial or navigational platforms) *Underwater Ordnance Weapons* (torpedoes, depth charges and related mechanisms) and *Missile Sub-Systems* (mechanical, electro-mechanical or electronic controls). *For complete details, address inquiries to: Dept. AW-12,*

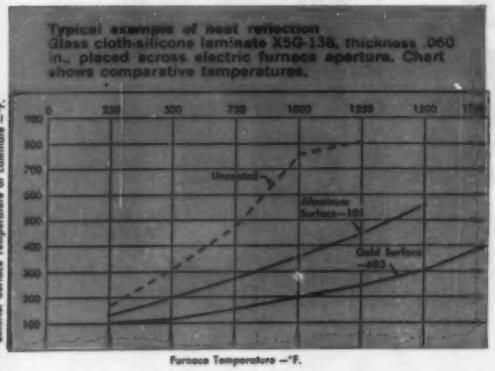
MECHANICAL DIVISION
1620 Central Avenue, Minneapolis 13, Minnesota

General Mills

To wider worlds—through intensive research • creative engineering • precision manufacturing



Now, reflect up to 1750°F radiant heat from SWEDLOW metallized laminates


Typical example of heat reflection
Glass cloth-silicone laminate X50-138, thickness .060 in., placed across electric furnace aperture. Chart shows comparative temperatures.
Exterior Surface Temperature of Laminate —°F.
Furnace Temperature —°F.
Uncoated
Aluminum Surface—101
Gold Surface —603

Compound shapes—minimum weight and bulk—highly efficient reflectivity—distinguish these materials and solve the problem of resistance to elevated temperatures.

Swedlow's solution for light weight heat protection problems uses a base of fiberglass fillers. To these are added any of an impressive variety of silicone, phenolic, epoxy, TAC polyester or polyester binders to meet specific service conditions. The resulting high-strength laminate is furnished flat or molded to any contour desired. Metallic coatings then further increase heat reflectivity and resistance. Swedlow-pioneered Type -101 aluminum coating is now in wide use for the 200°F to 1400°F range. The more recently developed Type -603 gold now raises the limit to approximately 1750°F.

Swedlow research is continuing the development of many combinations for the growing variety of aircraft, missile and electronic applications. To learn how these new materials can help solve your heat problems, contact the Swedlow plant nearest you. Or send for new literature—"Radiant Heat Reflective Laminates." Please refer to Dept. 10.

SWEDLOW Inc.

Formerly Swedlow Plastics Company

Los Angeles 22, Calif.
Youngstown 9, Ohio

There's experience behind these switches that assures the reliability you must have

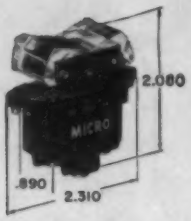
MICRO SWITCH grew up with the aircraft industry. For 20 years our engineering specialists have worked in close cooperation with the aircraft and missile industry—developing precision switches of unerring reliability for applications where component failure is intolerable. It is our business to know how to best help you meet ever changing switch requirements. There are always new switches on the drawing boards and on test at MICRO SWITCH. Some may solve your switching problems immediately. Save time, save money, consult with MICRO SWITCH aviation switching specialists.

Shown here are samples of a few types—some of them with hundreds of variations—that are making history in aircraft, missile, rocket and launcher design.

For complete information on the complete line of MICRO SWITCH products for the aircraft and missile industry call the branch office near you. See the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches



"TP" rocker actuated switch with sealed actuator and cover. Translucent or transparent keys.

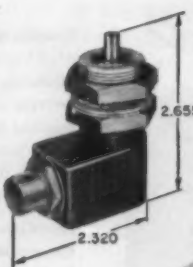
(Data Sheet 141)

"AT" toggle switch assemblies may actuate from one to as many as a dozen basic switching units.

(Catalog 73)

"HR" Series hermetically sealed switches operate dependably up to 600°F. Switch shown has roller plunger actuator.

(Data Sheet 122)



"EN" Series hermetically sealed switches. Switch shown withstands high shock . . . meets requirements of MIL-S-901B.

(Data Sheet 152)

COOL CARGOMASTER!

From General Motors—Temperatures Made to Order! Harrison Cools Engine Oil for New Douglas C-133A Transport!

Harrison Aircraft Oil Coolers—Another Quality Product of General Motors Research

High-speed, high-capacity hauling is a cinch for this giant of the sky! It's the Air Force's fabulous new flying freighter . . . the Douglas C-133A. Powered by four mighty turboprop engines, the huge Cargomaster ranges 3500 nautical miles with a 40,000-pound load . . . up to 1400 miles with a 95,000-pound load. But heat's no problem with Harrison on the job. Rugged, reliable Harrison oil coolers get first call from Douglas . . . just as they do from many other makers of America's most modern aircraft. They're another product of Harrison's never-ending search to conquer excessive heat under any flying conditions. If you have a temperature control problem, look to Harrison for the answer!

TEMPERATURES MADE TO ORDER

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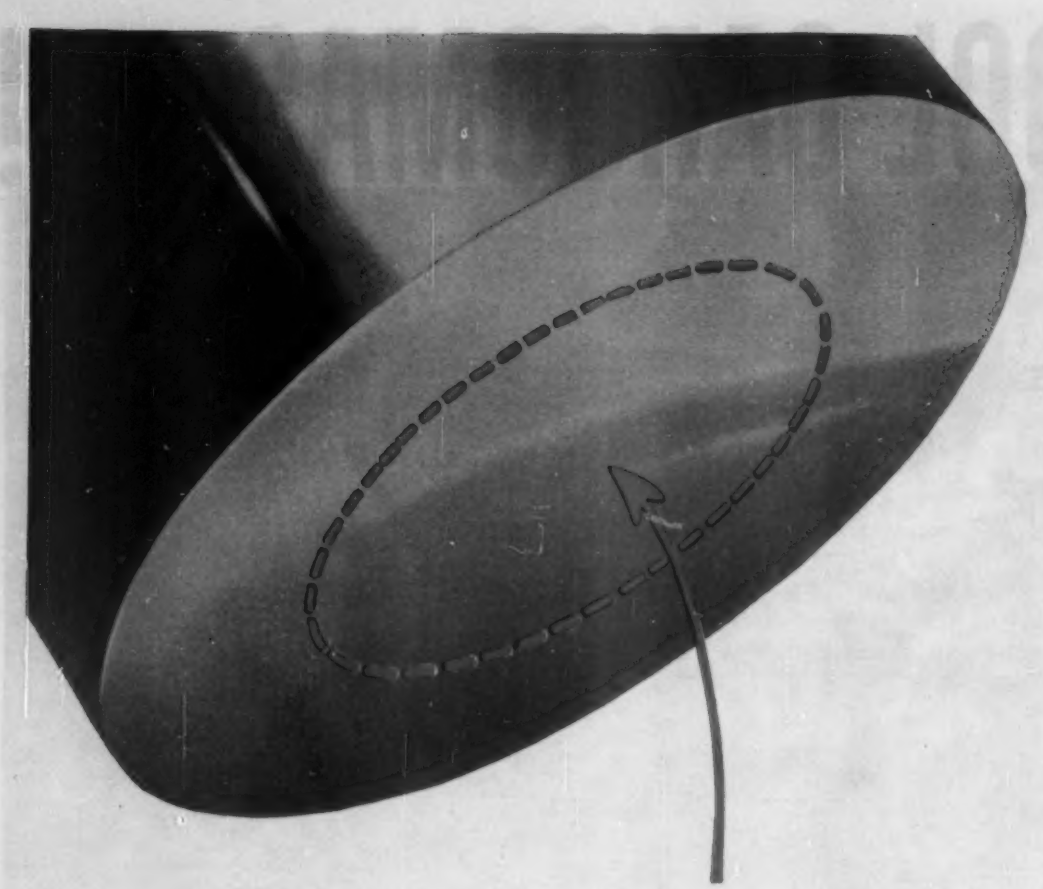
AIRCRAFT, AUTOMOTIVE, MARINE AND INDUSTRIAL HEAT EXCHANGERS

GM GENERAL MOTORS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK



Here's where hollow parts makers can find new savings

IF YOU'RE boring out bar stock to make hollow parts, you can save money, time and steel. Start with Timken® seamless steel tubing because:

1. YOU SAVE THE COST OF DRILLING; the hole's already there. Finish boring becomes your first production step.

2. YOU SAVE MACHINE TIME by eliminating this costly, original boring operation. You free screw machine capacity for other jobs, increase machining stations *without* adding machines.

3. YOU SAVE STEEL BY WASTING LESS and using more of the steel you buy. You get more parts per ton of steel, because there's less metal to hog out.

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B.F.Goodrich

B. F. Goodrich Unilock Rivnuts® designed especially for aircraft and missiles

New lightweight steel Rivnuts with thread-locking feature preserve structural strength... save assembly time and costs

Ordinary anchor type fasteners used in aircraft and missiles require as many as three holes. And installation is made by two men who must have access to both sides of the work.

But new B. F. Goodrich Unilock Rivnuts can be installed by *one* man from *one* side of the work. Only one hole is needed. And the job can be done at any time during or after assembly.

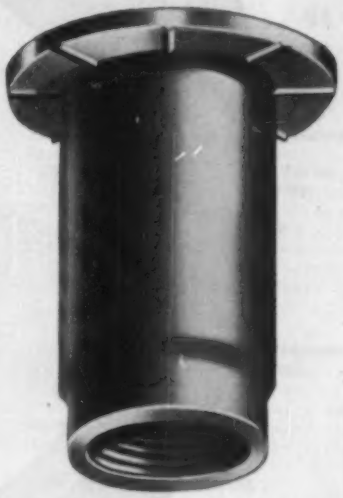
This greater flexibility in manufacturing procedure means a substantial savings in cost. In addition, with only one hole required instead of three, greater structural strength is maintained.

B.F.Goodrich Unilock Rivnuts, in fact, actually reinforce holes. That's because the equally spaced V-teeth under the Rivnut heads lock the Rivnuts to the material in which they are installed. This eliminates the need for a key and keyway — elements which ordinarily set up points of stress concentration.

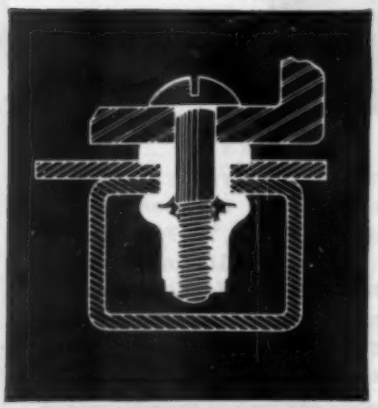
The thread-locking feature is a short crimp in the shank of B. F. Goodrich Unilock Rivnuts. This provides attaching screws with an all-metal interference fit that locks them securely in place.

Made from aircraft quality alloy steel, B. F. Goodrich Unilock Rivnuts are actually lighter than most anchor type fasteners. Yet they will meet strength and torque requirements of Military specification MIL-N-25027 for lock-type nuts.

B. F. Goodrich engineers will be happy to make recommendations concerning the use of Unilock Rivnuts in your products. For complete information write *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. AW-59A, Akron, Ohio.*



B. F. Goodrich Unilock Rivnuts are basically the same in appearance and function as regular type Rivnuts. However, the Unilock design is identified by the V-teeth under the head and the crimped shank end which provides the thread-locking feature. Radial marks on top of the head readily indicate grip range.



Typical Unilock Rivnut installation in blind application. Installation principle is same as for regular Rivnuts.

Equally spaced V-teeth, made as an integral part of the under side of the head, engage with surface of material in which the Rivnut is installed, thus providing high torque resistance and eliminating need for keyed head and slot.

B.F.Goodrich ***aviation products***

FIREBEE ··· THE HIT OF PROJECT WILLIAM TELL

"I'LL NEVER WANT TO FIRE AT TOWED TARGETS AGAIN!" That's the typical reaction of Air Force interceptor pilots after they fired at Ryan Firebee jet targets during the recent "Project William Tell" Weapons Meet. 78 Firebees, launched off the Florida coast, brought combat realism to the 10-day meet. Acting as "enemy" jet bombers, the free-flying Firebees streaked in at over 500 mph, from 14,000 to 42,000 feet, and flew an average of 31 minutes each. Air Force pilots, crews, and weapons systems met this realistic test with the most impressive teamwork and skill ever displayed at a weapons meet.

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May 18, 1959

Aviation Week

Including Space Technology

Vol. 70, No. 20
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COVER: North American A3J-1 Vigilante Navy attack aircraft is well into flight test phase at Edwards AFB. Navy has awarded North American's Columbus Division an $80 million follow-on contract for production of additional A3Js (AW Feb. 2, p. 37). All-weather jet can deliver a nuclear weapon which is fired to the rear from a linear bomb bay tunnel in aft section of fuselage. For production line views, see p. 140.

PICTURE CREDITS

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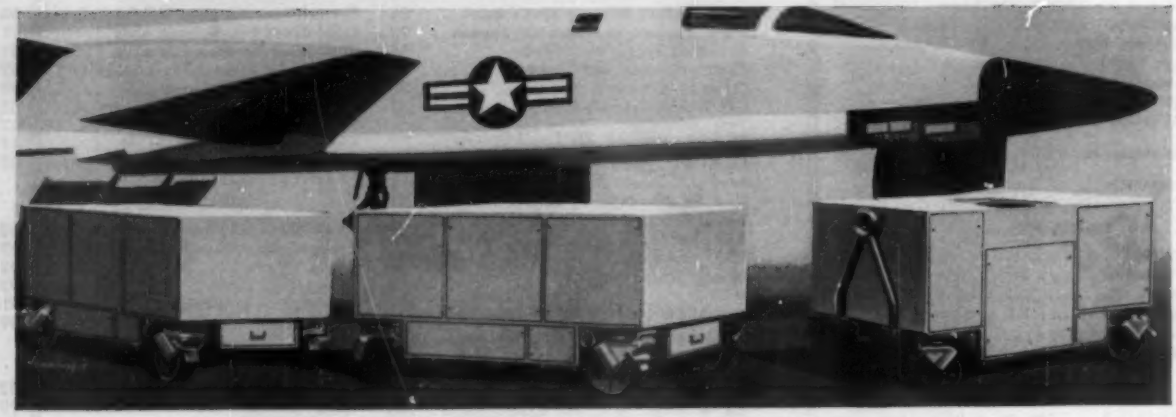

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EDITORIAL

Titans and Monkeys

If the 21st annual meeting of the Aviation Writers Assn. served no other useful purpose, and we trust it did, the entire affair would have been justified by the illuminating of Defense Department censorship policies by the participants in the forum on freedom of information. The principal burden of the forum was carried by Rep. John Moss (D.-Calif.), chairman of the House Subcommittee on Government Information, and Murray Snyder, Assistant Secretary of Defense for Public Affairs. The main subjects around which the debate revolved were Titans and Monkeys.

For many months, Rep. Moss, in concert with many editors and even a special committee appointed by the Defense Department to investigate its information policies, contended that Defense Department information policies are not based upon the single goal of attempting to maintain secrecy on items of genuine military security but are actually aimed at manipulating information to create a specific impression (favorable, of course) regarding the Department's activities at home and abroad. For an equal period, Mr. Snyder has been piously denying any such intent or actions and maintaining that military security was the only consideration regulating the flow of information from the Pentagon.

Under the skillful scalpel of Rep. Moss, the outer layer of confusion was deftly removed and the facts revealed, primarily on the evidence offered by Mr. Snyder himself.

First, lets take the case of the Titan, an intercontinental ballistic missile built by the Martin Co. for the Air Force at Denver, Colo. External configuration of the Titan was removed from security classification by the Department of Defense with USAF concurrence on Mar. 3, 1958, when the missile itself moved from the protective confines of the plant buildings to erection in an open-air static test stand 115 ft. tall where the 90-ft.-long missile began its test program. USAF requested public release of external Titan pictures shortly after all military security classification was removed. Despite the recommendations of USAF technical experts, Mr. Snyder refused to authorize any release, allegedly on the ground of military security.

Next step was enterprising Denver newspaper and television station requests to photograph this new addition to the local skyline from adjoining public property and the non-restricted airspace above. USAF confirmed that the airspace around and above the open Titan static test stands was not restricted and freely navigable by anyone who had an aerial vehicle at his disposal. These aerial pictures and others taken from a nearby public highway appeared in July, 1958, but Department of Defense still refused to release any non-classified Titan external pictures.

On Oct. 18, as part of a political speaking tour preliminary to the congressional elections on Nov. 7, President Eisenhower visited the Martin Denver plant and was photographed at close range inspecting a Titan in the static test stand. On Oct. 26, just two weeks before the election, this picture of the President with the Titan appeared in the Martin Co. plant publication and, later, in the general press. White House Press Secretary James Hagerty later denied that he had authorized the release of this picture, but those familiar with the mechanics of White House press operations are highly skeptical that any public relations man for a government contractor would use a picture of the President with a piece of new military hardware without obtaining White House clearance.

At any rate, Mr. Snyder stood firm on his principle and continued to withhold any release of Titan pictures until Feb. 6, 1959, when the first test firing of the Titan that could be purveyed as a "success" occurred at Cape Canaveral, Fla. And what was this principle that guided Mr. Snyder so firmly and steadfastly during the 11 months after all military security restrictions had been removed from external views of the Titan?

In his own words, as told to the Aviation Writers Assn., it was to prevent the American people from getting a false impression of the Titan's operational status and to prevent them from erroneously concluding that it was ready for full military use. This is, of course, what Mr. Snyder had previously denied doing for many months. But, in the heat of the debate with Rep. Moss, the truth slipped from Mr. Snyder's own lips. He is, as so many of us have long suspected, not really interested in military security but in creating "impressions."

The technical fact that a missile is just about as far away from military operational use when it begins its test firing program at Cape Canaveral as it is at the end of static tests in Denver does not appear to be a factor in Mr. Snyder's public relations equation.

He is, as so many have suspected, attempting to establish himself as the arbiter of what the American people should "think" about the news released from the Pentagon. And the evidence for these conclusions was provided by Mr. Snyder during the forum.

Now, what was involved in Mr. Snyder's other major concern for violation of military security? Monkeys!! Mr. Snyder originally labeled "confidential" the details of Defense Department policy on attempting to conceal the use of monkeys in space experiments. And, when the Moss subcommittee tried to penetrate this censorship fog, it received a letter from Robert Dechert, general counsel of the Defense Department, complaining that:

"It is our belief that your committee's actions in this matter have not only served to encourage disrespect for the security system but that the only real beneficiaries can be the Communist propagandists who want to stir up trouble between other nations."

Mr. Dechert also demanded that Rep. Moss reveal his source for this "secret information" so that said source could be prosecuted for security violations.

And, where is this "secret" source of information on the use of monkeys in space experiments? Well, the closest one, as revealed by Rep. Moss, is the Washington National Zoo where there are two monkeys displayed who have survived space experiments along with a detailed placard on their flight in a research rocket.

It would appear on the basis of his admissions at the Aviation Writers' forum that Murray Snyder has earned a niche along with his predecessors A. Karl Honoman and Robert Tripp Ross as a self-styled policeman of the people's thoughts whose policies can flourish only behind a cloak of administrative secrecy and cannot long survive when exposed fully to public view. —Robert Hotz

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When your problem is to make your electronic equipment perform efficiently under tough conditions, meet the challenge by asking Eastern for complete and creative engineering help.

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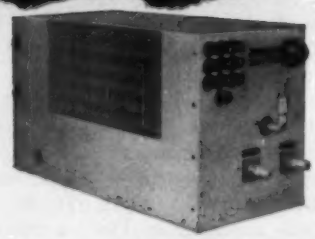

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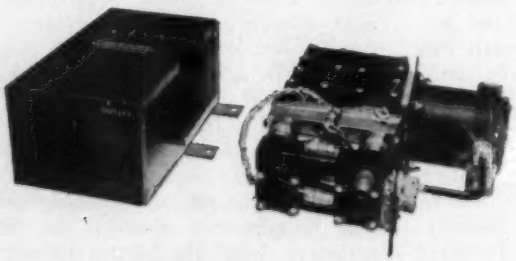

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Donald W. Smith, board chairman, Kearfott Co., Inc., Clifton, N. J. **Fred D. Herbert, Jr.**, succeeds Mr. Smith as president. Also: **Robert N. Brown**, a director.

John V. Tighe, special assistant to Deputy Administrator James T. Pyle, Federal Aviation Agency, Washington, D. C.

Sir Aubrey Burke succeeds **W. E. Nixon**, retiring, as chairman and managing director of deHavilland Holdings, Ltd., London, England.

James P. Falvey, board chairman, The Electric Auto-Lite Co., Toledo, Ohio. **Robert H. Davies** succeeds Mr. Falvey as president.

Richard W. Lee, president, General Precision Laboratory, Inc., Pleasantville, N. Y. Also: **William P. Hilliard**, vice president and general manager; **William J. Tull**, vice president-avionic engineering and sales.

Jack A. McCullough, board chairman, Eitel-McCullough, Inc., San Carlos, Calif. **Gould Hunter** succeeds Mr. McCullough as executive vice president.

Henry W. Harding, a director, Mohawk Airlines, Inc. Mr. Harding is president of Laboratory for Electronics, Inc. Other Mohawk appointments: **Russell V. Stephenson**, vice president-personnel; **Remington R. Taylor**, assistant vice president-maintenance and engineering.

Walter F. Munford, president and chief administrative officer, United States Steel Corp., succeeding **Clifford F. Hood**, retiring. Mr. Hood will continue as a director and member of the executive committee.

Barnet R. Adelman and **Herbert R. Lawrence**, vice presidents, United Research Corp., Menlo Park, Calif.

Carl L. Martin, vice president and general sales manager, and **Wilhelm F. Juptner**, engineering vice president and chief engineer, Babcock Relays, Inc., Costa Mesa, Calif. Also: **Gilbert Heavin**, production manager.

Dr. Robert N. Noyce, vice president and general manager, Fairchild Semiconductor Corp., Palo Alto, Calif.

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Dr. C. H. Stockman and **Henry C. Nields**, vice presidents, Goodrich-High Voltage Astronautics, Burlington, Mass.

William S. Ivans, Jr., a vice president, Cohu Electronics, Inc. Mr. Ivans continues as vice president-engineering for the Kin Tel Division, San Diego, Calif.

Honors and Elections

Henri Busignies, president of ITT Laboratories, has been awarded a 1959 Pioneer Award by the Professional Group on Aeronautical and Navigational Electronics for "outstanding work in the development of automatic radio direction finders for aircraft."

William J. Mitchell, Bonanza Air Lines' vice president-traffic and sales, has been elected vice president of the Air Traffic Conference of America.

(Continued on page 157)

INDUSTRY OBSERVER

► First Avro saucer-shaped, ground effect VTOL aircraft being build under U.S. Air Force and Army contract has been completed. First tie-down tests were scheduled to be made last week at Avro's Malton, Ontario, plant. Second "saucer" will be completed within the next few months and probably will be tested in the full-scale wind tunnel at National Aeronautics and Space Administration's Ames Research Center.

► **Air Force will greatly decrease vulnerability of existing air defense radars to enemy electronic countermeasures through installation of new frequency diversity radars capable of simultaneous operation over a wide portion of the microwave spectrum.**

► Army Ordnance will sponsor development of a cryogenic gyroscope at General Electric. New type gyro, which promises high accuracy and long life, was initially developed by GE's General Engineering Laboratory, Schenectady, N. Y., with company funds (AW April 27, p. 23).

► **Construction of two large rocket test stands for the liquid hydrogen-propelled second stage engine to be used by the Centaur space probe vehicle is being completed at Pratt & Whitney Aircraft's West Palm Beach, Fla., facility. Stands will be used to test the engine through its qualification period. Thus far, Defense Department's Advanced Projects Research Agency and Air Force have spent approximately $22 million on the Centaur project since awarding Pratt & Whitney a development contract for the second stage engine in October; Convair a contract for the Atlas first stage in November. Centaur third stage is being developed by the Jet Propulsion Laboratory.**

► Full-scale aircraft systems will be operated in nuclear radiation fields for the first time in June at the Georgia Aircraft Nuclear Laboratory operated by Lockheed's Georgia Division for the Air Force. First unit to be tested will be an ARC-34 ultra-high frequency communications set. Second unit will be an electrohydraulic system similar to many aircraft actuating systems.

► **Total weight of the avionics equipment to be carried by North American Aviation's B-70 Mach 3 bomber is expected to reach 10,000 lb.**

► North American Aviation has again recommended Westinghouse Electric as its choice to develop electronic countermeasures for B-70, following several months of careful restudy of three bidders' capabilities. Original North American recommendation was questioned by Wright Air Development Center because it felt that Westinghouse was a relative newcomer in the ECM field as compared with General Electric and Radio Corp. of America, which headed the two teams competing for B-70 ECM.

► **Air Research and Development Command hopes to obtain an additional $2-4 million in Fiscal 1960 to sponsor research and development work on molecular electronics (April 27, p. 54).**

► Results of Project Discoverer midair recovery attempts with large nets trailing from cargo aircraft will determine feasibility of using similar techniques in connection with NASA's Project Mercury man-in-space program.

► **New VTOL concept will be presented to the services by Lockheed in a formal proposal scheduled for late summer. Current test results have proven the concept to Lockheed's satisfaction, and patent litigation is in progress. Data from more exhaustive tests soon to be completed will be included in the formal proposal. Transition from vertical to horizontal flight, which has been difficult with many VTOL designs, will be a relatively "easy" flight maneuver, according to Lockheed officials.**

► Drone version of the Boeing B-47 bomber being developed by Lockheed Aircraft at its Marietta, Ga., plant is in the flight test stage. Numerous flights are being made with safety pilots aboard, but the aircraft are controlled from director aircraft and from the ground during takeoff and landing. Ultimate use of the drones will be to make practice penetrations of the North American defense system a more realistic affair.

MISSILE GUIDANCE OUTPOST

The Radar Course-Directing Centrals designed and produced by Stavid for the REGULUS missile provide the Navy a means of pin-pointing tremendous striking power against targets in hostile territory. Submarines now operational are capable of command-guiding the missile in flight, and provide missile crews with an automatic presentation of bearing and range information through data-stabilization and course computers.

Stavid's electronics capability is strikingly demonstrated in this task which required design and manufacturing skills ranging from the antenna to the computers – all developed and produced within our facilities.

The Stavid capability ranges from original research to system redesign for mechanized production. Recent accomplishments include:

- Gun Fire Control System Mark 70
- Radar Beacon for X-15 Aircraft
- Beacon Telemetering System

Stavid Section Engineer, Richard Holmberg, has 12 years' experience in electronics development, including project direction of guidance systems, electronic simulators and fire controls.

STAVID Engineering, Inc. Plainfield, New Jersey

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Outstanding engineers and scientists are invited to inquire into opportunities on Stavid's advanced systems engineering teams.

Washington Roundup

Nike, Bomarc: Invitation Accepted

Senate Armed Services Committee last week unanimously slashed the authorization for Army Nike Hercules installations and told Secretary of Defense Neil McElroy to come to Congress before its adjournment this summer with a "master plan" for air defense if he wants further authorization for sites, either Nike Hercules or the Air Force Bomarc. The cuts represent the committee's method of forcing Defense Department to come to a decision on the distribution of Nike Hercules and Bomarc in the system. Congress was invited to do this by McElroy in his testimony before the Appropriations Committee (AW May 11, p. 26).

Specifically, the committee took these actions in connection with the $1.2 billion military construction authorization bill:

- **Canceled all authorizations** for Nike Hercules sites made in previous years which have not been contracted thus far. These totaled 25 sites which were to have been equipped with 50 Nike Hercules batteries.
- **Reduced the authorization** for Nike Hercules facilities in the new construction bill from the $22 million proposed to $5 million for new construction at existing sites and for one new classified site overseas.
- **Authorization for Bomarc** construction is not specified in the legislation. However, a lump-sum allocation was voted the Air Force, and, in this, USAF has earmarked approximately $26 million for new Bomarc facilities.

Congressional Control

Congress is also determined to play a more decisive role in the selection of aircraft and missile weapon systems. A provision unanimously approved by the Senate Armed Services Committee last week requires the Defense Department to obtain congressional authorization for all programs for "the design, development and procurement of aircraft and missiles" before seeking funds to implement them. The provision, attached to a $1.2 billion military construction bill, appears certain of enactment. It would mean that the House and Senate Armed Services Committees would review the programs each year, before the two Appropriations Committees considered their budgets.

ICBM Need

Air Force sees a continuing need for Atlas and Titan ICBMs after the solid-propellant Minuteman becomes available for action against a wide assortment of targets because of former's larger warheads, according to USAF chief scientist Joseph V. Charyk.

FAA Hits Budget Cuts

Meanwhile, Federal Aviation Agency last week warned that the $76 million cut in its budget by the House of Representatives would force a "stretchout in the planned program for modernization and expansion of air navigation and air traffic management system." The House Independent Offices Appropriations Bill, which contained the budget reduction, now moves to the Senate for action. In its protest against the budget slice, FAA said it would be forced to make a cutback in its present personnel complement by about 900 persons and drop its plans to hire an additional 5,891 employes to man new facilities and to meet increasing workloads. Some equipment already procured could not be placed into operation because of the lack of manpower, the agency said.

This equipment includes 166 Vortac facilities, 17 long-range radars, 19 terminal radars, 28 traffic control towers, 44 approach lights systems and 24 instrument landing systems.

Cargo Airlift Plan

In another area, Defense Department is holding discussions with FAA on a program to develop a new cargo aircraft which can be used in both civil and military operations. In a letter to Sen. Stuart Symington (D.-Mo.) and Sen. Mike Monroney (D.-Okla.), the Department pledged its full support to the program.

Sen. Monroney has proposed a $1 billion program for a fleet of 400 efficient cargo aircraft—300 for commercial carriers and 100 for Military Air Transport Service (AW April 6, p. 25).

Meanwhile, in testimony before the House Military Government Operations Subcommittee, Assistant Secretary of Defense Perkins McGuire cautioned:

"The responsibility for the development of civil air cargo capability cannot rest on defense alone. . . . We are prepared to assist wherever we can, but the carriers themselves must vigorously support the development of modern aircraft."

New Name for AIA

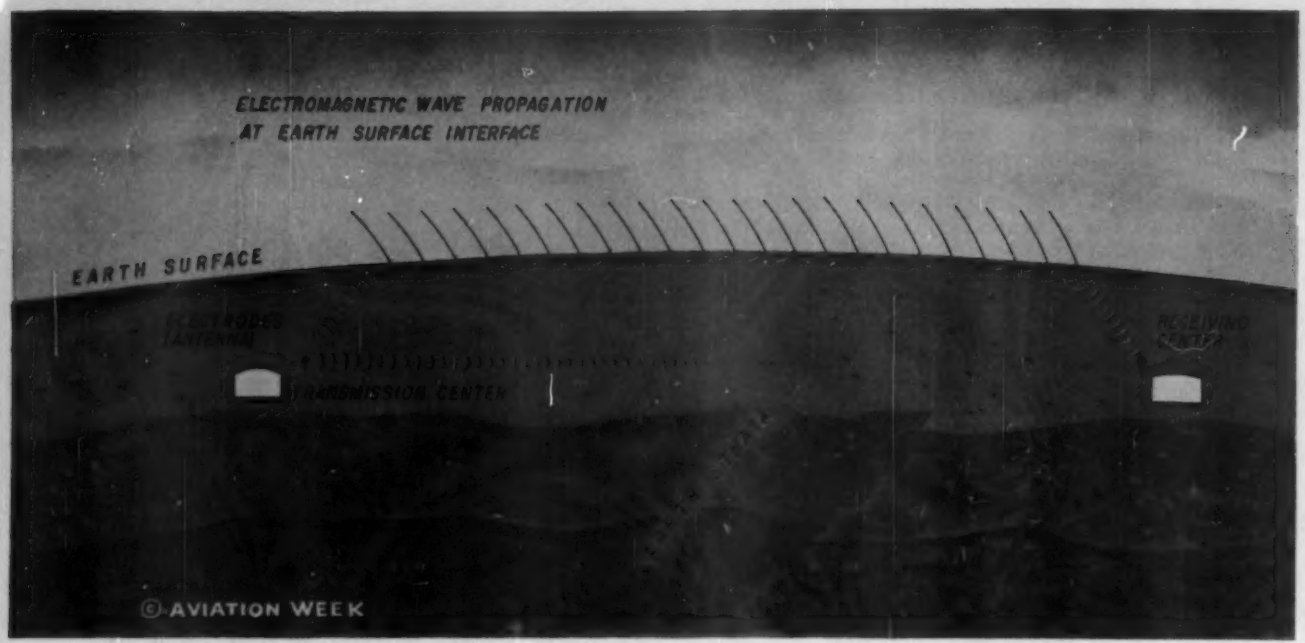
Aircraft Industries Assn., after a long debate, adopted a new name last week—the Aerospace Industries Assn.—"to reflect the changing nature of the work being performed by the industry." Serious move for a name change had been under way since last fall, but debate as to how a new title should be developed caused a series of delays in the final decision (AW Oct. 27, p. 25; Nov. 24, p. 25).

"By our definition," AIA President Orval R. Cook said last week, "'aerospace' embraces research, development and production of manned and unmanned vehicles and their supporting equipment for movement above the earth's surface. . ."

"Use it or Lose it"

"Use it or lose it" formula adopted by the Civil Aeronautics Board in an effort to determine the need for air service at 95 intermediate communities was roundly criticized last week as an unfair yardstick by a Board examiner. In a case involving the renewal of Trans-Texas Airways authority to service 15 small communities, Examiner Thomas L. Wrenn said that although CAB had not stated definitely that the formula would apply to the Trans-Texas Case, it had advised that service at cities generating less than five passengers a day "might not be continued." Urging a greater emphasis on the factors of public convenience and necessity, Wrenn said the passenger yardstick is deficient in that it fails to consider the distances traveled by many passengers; makes no allowance for the flight range in carrier breakeven needs, and does not recognize the difference in city sizes.

—Washington staff



EARTH CURRENT communication system consists of transmission center buried a few hundred feet below earth's surface which sends alternating current through insulated electric cables to pair of buried electrodes. Signals would be of low frequency and confined to a narrow band. Electrodes act as an oscillating dipole antenna and disseminate signals into the earth. Propagation of the electromagnetic energy takes place at the earth's surface in a region near the interface; signals are picked up by the receiving center.

New Concept to Trigger ICBM Network

Use of earth to transmit 'unwired' signals may provide Air Force with jam-proof communications channels.

By Irving Stone

Glendale, Calif.—Simple concept of using the earth to transmit signals promises to provide the key to the critical problem of a relatively invulnerable communications link between buried ballistic missile launch sites and their buried control centers.

Research with transmission of subsurface electromagnetic waves, or "earth current," already indicates that this "unwired" scheme may be feasible for "alert" and "execute" commands between command posts and control points and between control points and missile sites. Estimates are that a prototype system probably could be developed in a year, and with sufficient support a SAC-type operational system might be available within two years.

Military planners and weapon system designers consider the communications link one of the most vital for the ability to retaliate following nuclear attack. Surviving missile sites and command post control centers would be useless if communications between them were knocked out or sabotaged.

Implementing this philosophy, subsurface electromagnetic radiation as a communications technique has been under investigation here by Space Electronics Corp. for almost a year in a study partially funded by the Air Force. SEC says that the subsurface electromagnetic radiation, or earth current approach, potentially offers great advantages over conventional communication nets such as radio systems or hardened telephone lines. High frequency, very low frequency and microwave conventional antenna installations are costly to harden. Many of the present radio systems might abort under atomic bombardment because of propagation disturbances. Wire lines also are expensive to harden and are subject to sabotage. By contrast, the only way to permanently disrupt earth communications would be to destroy the transmitter or receiver, SEC says.

Earth current communication systems, although less efficient than conventional communication means, probably can meet military requirements in a hardened concept at a considerably lower cost. Space Electronics Corp. will not comment, but AVIATION WEEK has learned that a practical earth current communications system may cost hundreds of millions of dollars less than a deeply buried conventional cable system.

SEC refers to its subsurface communication scheme as LOREC (long-range earth current). Subsurface transmission of electromagnetic waves for communication is not a new concept, and it has been established that low-frequency electrical signals can be propagated for short distances below the surface of earth or sea. But, for effective communications over appreciable distances, subsurface electromagnetic waves were believed to offer little promise because of very rapid attenuation of waves when propagating through a conducting medium. The challenge lies in the refinement of the phenomenon into a practical system, to establish a communications link between sites of a hardened missile complex.

Initial experiments with the earth current scheme were conducted with water as a medium. SEC scientists chose California's Newport Harbor for the experiment and used a transmitte

housed in a coffee can, which was lowered to various depths. The amount of power that could be received at a given distance proved to be a function of depth of both transmitter and receiver.

Also, separation of transmitter and receiver was varied in the experiments, as well as the frequency used.

By use of appropriate equations, Space Electronics Corp. scientists were able to scale the underwater experimental results to earth conductivity values, since the basic difference between the two mediums is in degree of conductivity.

Since the water experiment merely was to test the concept and check the propagation laws, the next step was to begin experiments with earth as the conducting medium. The location chosen was directly across Glendale's Grand Central Airport, a distance of about one-half mile. Favorable results indicated that the system was practical, and an intensive program was begun. SEC will not comment concerning other experimental site locations, but AVIATION WEEK has learned that trials also are being continued in a borax mine site near Edwards AFB, Calif.

Basically, here is how the earth current system would work: A transmitter buried a few hundred feet below the earth's surface would send alternating current through insulated electric cables to a pair of buried electrodes. Signals would be of low frequency and confined to a narrow band. The electrodes would act as an oscillating dipole antenna and disseminate the signals into the earth over a wide area and angle.

Propagation of the electromagnetic energy, or energy channeling effect, takes place at the earth's surface in a region near the interface, which is a relatively narrow band on either side of the surface. Because of this interface phenomenon, more effective propagation and guidance of signals to a distant point can be provided than previously anticipated.

Although the propagation phenomenon is clearly understood—that the energy propagates not only subsurface, but partially above surface as well—the efficiency of these transmissions still will require highly sophisticated mathematical techniques for development of a feasible system, SEC declares.

Various factors will require solution or compromise in the perfection of the system:

• **Depth selected for transmission** and receiving locations will be a compromise between conductivity and vulnerability.

• **Low frequency signals suffer** less attenuation in transmission than high frequency signals and, over long distances, attenuation becomes critical. The deeper the installations are placed, the lower the frequency required because of the skin-depth phenomenon—the deeper the transmission the more difficult it is to get the wave to the interface.

This relationship of depth to frequency thus becomes a tradeoff. On the one hand, it is generally more difficult to use low frequency transmission because equipment becomes larger, more complex and more expensive. On the other hand, it is advantageous to stay as close to the surface as possible without actually emerging, but the less the depth below ground, the more vulnerable the system.

• **Although increased power** over that of conventional, above-surface installations will be required, equipment requirements for buried installation will be feasible, SEC scientists say. High powers will be used, but if message lengths can be limited, the total energy required will be reasonable. Nevertheless, the greater the transmission distance, the more power required, and, in the final analysis the resolution of distance versus power will be a tradeoff.

• **Narrow bandwidth of the system** will limit the amount of information sent during a given period but is necessary in order to give a good signal-to-noise ratio at the receiver. Despite the relatively narrow bandwidth, advances in coding techniques make possible the communication of considerable information within a short time, SEC scientists say. Also, frequently, the signal might be restricted to a simple alert or execute command.

• **There is a relationship** between power required and noise picked up at the receiver. If noise can be eliminated or minimized, the amount of transmitting power will be able to be reduced. Present advances in devices for canceling noise and effectively transmitting true signals are promising, SEC declares.

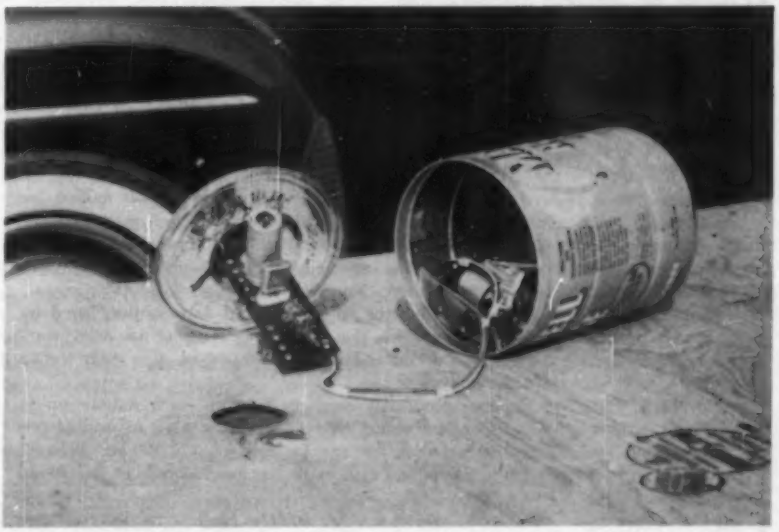
• **Interference from all** sources of electromagnetic radiation will be a factor in the development of the system.

• **Transmitting and receiving** will be different from present day conventional practices. Development of electrodes (antennas) will be a tricky part of the over-all development problem.

• **Terrain above and between** transmitting and receiving locations will have to be considered in the installation. Generally, the flatter the earth's surface, the better the system characteristics.

• **Discontinuity in the earth** strata through which the transmission is made will be another consideration but a minor one. Discontinuities may be a sudden change from rock to sand, gaps and cracks in the strata or presence of water. Various strata are being investigated, but, if the layer is uniform, the problem resolves itself to one of conductivity—selection of a stratum which requires the least skin depth.

A relatively young company, Space Electronics Corp. was formed in July, 1958. It is headed by Dr. James C. Fletcher, president, who previously was director of Electronics Laboratory at Space Technology Laboratories, and Frank W. Lehan, vice president, who formerly was associate director of STL's Electronics Laboratory. The company now has approximately 50 employes, about 25 of them members of the technical staff. Company is partially owned by Pacific Automation Products, Inc., of Glendale, Calif.



EXPERIMENTAL transmitter housed in a coffee can was used in preliminary underwater experiments by Space Electronics Corp. to determine the feasibility of using subsurface electromagnetic waves for a communications link. The transmitter was lowered to various depths in the water; the amount of power that could be received at a given distance proved to be a function of depth of both transmitter and receiver.

Single Manager Concept Gains Support

By Katherine Johnsen

Washington—Strong support for a "single" weapon system manager—rather than a series of "associate" managers—has developed in the House Armed Services Investigating Subcommittee during its study of weapon system procurement.

At the outset of hearings a month ago subcommittee members were opposed to the single manager on grounds that it gave one manufacturer a blank check for the development of a system. During its latest hearings on management of the Atlas intercontinental ballistic missile program, subcommittee chairman Rep. Edward Hebert (D.-La.) said that, under the single manager concept, the Air Force, or other military service, still retains ultimate responsibility. He also commented that "the heart of the thing is single management versus multiple management and multiple confusion."

Air Force's Ballistic Missile Division which has direction of the Convair Atlas intercontinental ballistic missile program has delegated over-all technical direction to Space Technology Laboratories, formerly Ramo-Wooldridge Corp. (see p. 54).

Division of Atlas Funds

J. V. Naish, president of the Convair Division of General Dynamics Corp., reported that funds in the Atlas program are divided in this proportion among the five associate managers:

- **Convair, for airframe,** autopilot, and integration of all systems, 52%.
- **Rocketdyne, for engine,** 17%.
- **General Electric Co.,** for nose cone and guidance, 22%.
- **Burroughs Corp.,** for guidance, 3%.
- **American Bosch Arma,** for guidance, 6%.

Rep. Hebert called the Atlas program management "a Mulligan's stew." Rep. Porter Hardy (D.-Va.) said it was a "screwball arrangement under which contractor responsibility is so diluted that no one contractor would have to take any blame if a missile were never developed."

Vega Management Plan

Naish reported that the Vega space vehicle booster program sponsored by the National Aeronautics and Space Administration, and one which Convair will manage, will have the same type of management as the Atlas.

Convair, which had spent almost 10 years in the development of Atlas and predecessor programs, had planned to continue as the single manager, Naish said, but in 1954 the Air Force decided to broaden the industrial and talent base by bringing in associate contractors and Space Technology Laboratories (then Ramo-Wooldridge). This is the point at which the Atomic Energy Commission gave assurance that a small, high-yield warhead could be counted on and USAF moved into an all-out ICBM program.

Convair turned its technical reports over to each associate contractor. Under questioning, Naish said that "the evolvement of systems demonstrates . . . that quite obviously they followed these engineering studies."

J. R. Dempsey, vice president of Convair and manager of its Astronautics Division, said in reply to questions that no innovations were introduced into the Atlas program by STL or its predecessor. He said STL's role has been "to ask questions and make sure we are doing the right thing." Rep. Hardy remarked that "they stimulate you to use your own capabilities. . . ." Rep. Hebert said he viewed STL's role as "efficiency experts to tell you how to run your business."

On the spread of Convair's portion of the Atlas program throughout the economy, Naish reported:

- **Of the 52% of Atlas** funds that go to Convair, 30% is subcontracted and 22% retained by Convair.
- **Of the subcontracted portion,** 74% goes to small business and 26% to large business. Eighty firms which started working on Convair Atlas subcontracts as small businesses, he said, have advanced into the category of big business—firms with over 500 employes.
- **Geographically, Convair** Atlas subcontractors are located in every state except six: Nevada, Idaho, Maine, Mississippi and North and South Dakota.

Defense Department is opposed to a provision in comprehensive procurement legislation introduced by Sen. Leverett Saltonstall (R.-Mass.) that would require the use of the single weapon system manager unless there were special reasons for justifying another type management.

In a report to Senate Armed Services Committee, the Department, in effect, said it wanted to continue to have a completely free rein in selecting the type of management (AW May 4, p. 32). An armed services subcommittee is expected to be appointed soon to hold hearings on the Saltonstall measure.

Other Developments

Two other developments were:

- **Numerous small business** firms have protested to the Senate Small Business Committee that the Saltonstall provision for the single manager and another provision of the bill would elevate competitive negotiation to equal status with the advertised bid as the preferred type of procurement.

Sidney M. Kaplan, president of Systems, Inc., of Orlando, Fla., a small-business electronics firm, told the committee:

"The only way to genuinely increase small business participation in weapon system programs is by eliminating the single manager concept and giving the coordinating responsibility and contracting authority back to the Department of Defense where it really belongs. . . . Elimination of the single manager concept is not inconsistent with weapon system planning. . . . It is not essential that the technical coordination

Communication Satellite Cost

Washington—Advanced Research Projects Agency has budgeted $60 million for development of communication satellites in Fiscal 1960, approximately four times the current year's funding, according to ARPA Director Roy W. Johnson. ARPA's communication satellite development effort is expected to reach its peak in about three years with an annual expenditure of more than $100 million.

Recent report by the House Committee on Science and Astronautics, based on testimony by industry spokesmen, predicts that a global network of 16 active communication satellites could be produced and placed in 1,000-mi.-high orbit for an estimated cost of $100-$150 million.

At this altitude, the satellite could relay messages between earth stations up to 4,000 mi. apart and handle 800 simultaneous teletype messages. Cost of manufacturing the larger communication satellite, for use in hovering (22,300-mi. altitude) equatorial orbit is estimated at $4 million each, with another $24 million for ground installations.

The House report commends communication satellite progress to date but cautions that "there must be no letup of effort through lack of funds or indifference. The very existence of this country in large measure is dependent upon the success of these efforts." (For detailed story on ARPA's communication satellite program, see Aviation Week, April 27, p. 28.)

be performed necessarily by government personnel.

"Excellent examples exist where non-profit but private organizations such as Applied Physics Laboratory, Johns Hopkins University, Jet Propulsion Laboratory, California Institute of Technology have accomplished the coordination . . . and more can be encouraged to do this kind of thing and even more in the way of actual management of hardware phases. Projects must not be inhibited at the start, however, by turning the responsibility over to potential competitors of equipment manufacturers as was done in the case of Ramo-Wooldridge."

• **The 44-member New York** congressional delegation launched a move for legislation requiring that all negotiated contracts "incorporate procedures of competitive negotiation to the greatest extent practicable. . . ." Behind the move is New York's substantial unemployment and the shift in defense spending from New York to western states, notably California. While California has increased its share of the dollar-volume of defense prime contracts from 13% of the total to 21% over the past eight years, the percentage going to New York has declined from 18% to 11%. Pointing out that California increased its percentage to 27% during the latter part of 1958, Sen. Jacob Javits, (R.-N.Y.) anticipated that the concentration of defense business in the state would increase even more with the shift from aircraft to missiles, unless action is taken.

"Our legislation," Javits said, "would give defense production firms in the New York areas and every other hard-hit area an equal opportunity to compete for multi-billion-dollar prime contracts now awarded through negotiations. Once that opportunity is secured, I believe that the incentives to competition will be sharper and that New York and other eastern states will gradually regain on the merits some of the billions of dollars in defense work presently being so heavily allotted to West Coast firms."

Proposed Renegotiation Changes Broaden Industry Appeal Rights

Washington—House Ways and Means Committee last week voted three key changes in the Renegotiation Law that could smooth the way for aircraft manufacturers contesting Renegotiation Board determinations of excessive profits in court cases.

Other changes made by the committee in approving a four-year extension of the law to June 30, 1963, were viewed by aircraft industry spokesmen as "most trivial in placing any restraints at all on the Board. The committee did not even establish a minimum yardstick of profits to curb the unlimited administrative power of the Board."

The measure, as approved by the House Ways and Means Committee, now faces a probable fight on the House floor led by Rep. Carl Vinson (D.-Ga.), chairman of the powerful House Armed Services Committee, who wants the law "as is" made permanent.

These are the three changes:

• **Excessive profits determinations** of the Renegotiation Board are no longer to be presumed correct by the Tax Court in contested cases. The Tax Court at present has a rule that "the burden of proof shall be upon the petitioner . . ." Renegotiation Board's Chairman Thomas Coggeshall defended the rule in congressional testimony as "but another application of the traditional principle of Anglo-Saxon jurisprudence that the burden of proof rests upon the moving or petitioning party, the party who seeks to invoke the power of the court. The petitioner in the renegotiation case in the Tax Court is the contractor . . ."

In addition, there is a provision that the Tax Court shall consist of "not less than three judges"—which contractors feel will make more balanced judgments possible. Renegotiation cases are now heard by a single judge.

• **Contractors are given** the right to appeal Tax Court decisions to the U. S. Court of Appeals. Tax Court decisions have generally confirmed the determinations of the Renegotiation Board. Rep. Vinson has taken the position that "the Tax Court should end the controversy. Two competent reviews by responsible tribunals are enough. Any more would encourage delay and create financial uncertainty."

• **Renegotiation Board,** before issuing an order of excessive profits, would have to give the contractor a statement detailing how and why it arrived at its decision. This information would assist the contractor in developing an appeal case.

The Renegotiation Law lists several general criteria by which the Board is to determine profits, such as "reasonableness of costs and profits," net worth, "extent of risk assumed . . . nature and extent of contribution to the defense effort," etc. The Ways and Means amendment would require the Board, in its statement to the contractor, to "indicate separately, but without evaluating separately in dollars or percentages, its consideration of, and the recognition given to," each of the criteria. Rep. Vinson claimed that this is "somewhat like requiring a jury to put in writing why they decided on a 'guilty' or 'not guilty' verdict. Judgment must at best be dependent upon innumerable factors, not the least of which may be comparisons, impressions of sincerity, history of past dealings, full disclosure of all pertinent facts, half-truths and general demeanor. Add to this the fact that contractors are not organized alike . . ."

In addition, the Board would have to let the contractor inspect all reports and other written matter furnished to the Board by government departments relating to the renegotiation case.

Seven aircraft manufacturers already have appeals against renegotiation determinations totaling $72.1 million pending before the Tax Court: Boeing Airplane Co., $26.8 million; Douglas Aircraft Co., $8.7 million; Lockheed Aircraft Corp., $4.2 million; The Martin Co., $3.2 million; North American Aviation, $17.7 million; Temco Aircraft Corp., $4.8 million, and Grumman Aircraft Engineering Corp., $6.7 million. All other renegotiation determinations being contested in the Tax Court total only $9.6 million.

Other changes by Ways and Means Committee which aircraft industry spokesmen view as "trifling" curbs on Renegotiation Board's authority to decide profits are:

• **Board would be required** to give consideration to the "contractual pricing provisions and the objectives sought to be achieved thereby . . ." Aircraft manufacturers have criticized that recaptures by the Board are defeating the objective of incentive-type contracts—an inducement to cut costs.

• **Board would give attention** to the government's capital investment instead of "particular" attention. The word "particular" was deleted by Ways and Means.

The basic reason for Renegotiation Board's heavy assessments against aircraft manufacturers and Rep. Vinson's attack on the industry is the weight the two give to government investment.

Measured against private investment, the profits of the industry are high according to Vinson. A tabulation on this basis released by Rep. Vinson shows these 1953 profits for aircraft companies: Boeing, 152%; Douglas, 148%; Grumman, 240%; Lockheed, 238%; Martin, 80%; North American, 612%.

• **Contractors would** be able to spread their losses over five years to offset excessive profits. At present, the losses can be carried forward for only two years on renegotiation business.

Mercury Crewmen Begin Space Training

By Craig Lewis

Washington—Project Mercury pilots have entered the early stages of their training and indoctrination program designed to give them the skills and knowledge they will need to operate the space capsule when they are sent into orbit.

After an initial two weeks of training at Langley Research Center, Va., the seven trainees went to St. Louis last week for briefings on the Mercury capsule from its prime contractor, McDonnell Aircraft Corp. This was the first of a number of trips they will make to contractors, firms, research centers and missile ranges that will be integrated with an intensive program of lectures and training at Langley.

National Aeronautics and Space Administration's Space Task Group has laid out a training program that will carry the seven volunteers to the point where they will be going into orbit. George M. Low, chief of the Manned Space Flight Program, detailed the project to the annual meeting of the Aviation Writers Assn. last week. It falls into these six broad categories:

- **Education in the basic sciences,** including work in astronautics, especially ballistics, trajectories, fuels, guidance and other aspects of missile technology, plus instruction in basic aviation biology, space environment, astronomy, meteorology, astrophysics and geography. Training will cover techniques for making scientific observations in these areas.
- **Familiarization with space flight** conditions covering such aspects as heat, pressure and force levels and including work in centrifuges and pressure chambers and weightless flying.
- **Operation of the Mercury capsule,** including thorough knowledge of the vehicle, development of skills for controlling it in flight, technical knowledge of boosters, propulsion systems and ballistics, familiarization with the test range, tracking and recovery systems.
- **Participation in the Mercury** development program, in which each pilot will work on a system or subsystem and acquire special knowledge which will be exchanged in a series of seminars.
- **Aviation flight training** to maintain proficiency in high performance aircraft.
- **Integration with ground support** and launch crew operation, providing a complete knowledge of the launch phase of the Mercury flights.

A typical week at Langley may involve morning lectures on such subjects as basic astronautics, tracking and the world-wide range for Mercury, basic aviation, physiology, capsule instrumentation and the flight path and range safety systems at the Air Force Project Missile Test Center, Cape Canaveral, Fla. Afternoons are spent working on simulators, doing proficiency flying, athletics and work on the various system development programs.

Redstone Flights

The six phases of the training program will be proceeding concurrently, and together they are expected to carry the pilots to the point where they will be boosted into orbit by a Convair Atlas. Before that happens, the pilots will have done the usual aircraft maneuvers which produce short periods of weightlessness. They also will have made training flights boosted by Redstones which will produce about five minutes of weightlessness. With the knowledge provided in this manner, Low said enough should be known about the effects of weightlessness to allow an orbital mission when the first manned capsule is ready to be launched by an Atlas booster.

Since Project Mercury is a research and development program in a new area, Low would not predict when the first flights may be made.

A number of different flight simulators will be used to familiarize the pilots with operation of the Mercury capsule. One example cited is a North American X-15-type pilot-control device in which reaction control jets are mounted on the arms of an iron cross. The pilot will fly this simulator to check the reaction control system and his ability to control them.

There also will be complete Mercury capsule mockups equipped with all the appropriate control and gages. Technicians outside the simulators will feed emergency features to the pilot display in the simulator to test pilot reaction and ability to make corrections.

Mercury pilots will not actually go through the emergency launch procedure designed as a safety measure in case of trouble in the booster launch phase. Low said this emergency system will be tested with animals, and the pilots will observe the emergency procedure in action.

Low pointed out that the Redstone flights will include a number of phases of the training program and that the Redstone flights will be the most realistic simulation of the actual mission encountered in the training program. Pilots will be subjected to the same g forces in the training program they are to encounter on their mission. This means a peak of 8.6g during launch, close to 9g during re-entry and 18-20g during the worst possible abort or escape conditions.

Temperature during re-entry may reach 150F in the capsule, although the pilot will be protected by a ventilated pressure suit. This temperature level will be simulated on the ground but not in the Redstone flights, although all the g forces will be simulated with the Redstone.

Pressure in the capsule will be about a third of an atmosphere, although oxygen partial pressure will be maintained at sea level values. Low said the atmosphere in the capsule may be pure oxygen. Although the crewman will wear a pressure suit during the entire flight, the faceplate will be open, and he will close it only in an emergency.

Denying that the pilot will be just going along for the ride if all the automatic Mercury systems work, Low said the crewman will be making

Pyrophoric Ramjet

Indianapolis—Initial development and test firings of a low cost, high performance ramjet engine which burns pyrophoric fuel has been completed by Allison Division of General Motors Corp.

Designated PD-37 Pyrodyne, the engine capability ranges from Mach 1 at sea level to Mach 3 at 80,000 ft. Engine is designed primarily for air-launched target drones but can be used in conjunction with a rocket booster for ground-launched targets. Thrust will be about 60 lb. at a Mach 2—70,000 ft. performance profile, and cost will range from $500 to $1,500 per engine.

High reaction rate of pyrophoric fuels (AW Oct. 27, 1958, p. 64) permitted use of smaller and simpler burners and short ignition delay led to significant reduction in combustion chamber and weight.

Plasma Engine Contracts

Washington—Plasma engine using a modification of the magnetic pinch effect which can maintain continuous, rather than intermittent, operation is being developed by Republic Aviation Corp. under contracts announced last week by the Office of Naval Research and the Air Force Office of Scientific Research. Present contracts for this development total $193,000. Republic has been pursuing this engine development for almost a year. The company estimates that the major problems with the engine will be solved during 1960 and that production units could be ready by 1964.

scientific observations and will be asked to perform navigation and control tasks to get human performance data. Pilots will switch off the automatic control system and work at such tasks as orienting the capsule. He also will keep track of his position so he can take over operation and navigation of the capsule in case of a system failure.

Low said the Mercury system will not have a capability for over-riding the pilot's controls from the ground. Such a capability, he said, would defeat the purpose of having the pilot in the capsule "because we feel the pilot plays an important part, especially in emergency missions."

Mercury pilot will have a navigation periscope to help him orient the capsule by observing the horizon in all directions. With this viewing device, he also will be able to see how quickly he is moving over certain landmarks and, by using tables and a stop watch, he can trace his course and location on his maps.

New Approach to Missile Defense Urged by USAF Chief Scientist

Washington—Development of an effective defense against enemy ballistic missiles that won't bankrupt the country will require fundamentally new approaches, probably involving systems designed to operate in space, Dr. Joseph V. Charyk, USAF chief scientist told the Aviation Writers Assn. here last week.

In a thinly veiled reference to Army's Nike Zeus ICBM defense system, Charyk warned that it is unrealistic to design a system that will take years to implement for use against unsophisticated first-generation missiles. Relatively simple, inexpensive modifications in second-generation ballistic missile configurations make it possible to alter trajectory or to dispense decoys which will drastically alter the nature of the defense problem and obsolete such an approach, Charyk said.

On April 27 (p. 23), AVIATION WEEK revealed that the Soviet Union already has test fired several new ICBMs employing a design which enables the nose cone to change its flight path from a simple ballistic trajectory.

In reply, Douglas Aircraft's Robert L. Johnson said that tests and calculations indicate that Nike Zeus can intercept and destroy extremely small, maneuvering targets. Furthermore, he said, Nike Zeus is designed to handle simultaneous attacks from any direction or elevation angle for targets ranging from ICBMs to Dyna-Soar type vehicles.

Without mentioning the USAF's Ballistic Missile Early Warning System (BMEWS) now under construction in the Arctic, Johnson said the U. S. must not overlook the threat of ballistic missiles launched in other than polar trajectories—such as submarine or air launched missiles, extremely long-range ICBMs on east-west trajectories, or missiles launched from other than present Communist territory.

The only "sure thing," Johnson said, is that such missiles will be aimed for strategic retaliatory targets in the U. S. and that these are the logical places to locate ICBM defense systems.

Johnson urged a reversal of Defense Department decision to hold back on procurement of long lead-time facilities and production planning of the Nike Zeus program. Failure to take such action now will leave a serious gap in the nation's defenses, he said, and reduce the retaliatory threat to an enemy.

The chief of Douglas's Missiles and Space Projects conceded that decoys pose a problem for any ICBM defense system but said the Nike Zeus data processing computers have sufficient capacity to track many targets.

Charyk said it is possible for a ballistic missile nose cone to dispense hundreds of decoys that will produce a radar echo similar to that of the real warhead, each with a different impact point extending over hundreds of miles. Decoys can be designed to have the same drag-to-weight ratio so as to make it difficult for data processing computer to distinguish between decoys and the warhead. This leaves the defense no choice but to fire anti-missile missiles at each target, Charyk said. The cost of building sufficient anti-missile missiles to do this could bankrupt a nation, he suggested.

Development of an effective and economically sound ICBM defense will require exploration of new and novel approach now largely in the paper stage and increased knowledge about the behavior of ballistic missiles after launch and during re-entry. This knowledge is almost nonexistent at present, Charyk said. Both programs are under way under Advanced Research Projects Agency sponsorship.

Until these research programs disclose a feasible ICBM defense approach, Charyk said, the U. S. can protect its retaliatory capability more effectively and economically by a combination of dispersal, hardening and mobility. As an example of the gains of hardening, an exposed missile of the Atlas or Titan-type in a non-hardened site would be damaged by the blast from a two megaton warhead that hit within a radius of approximately eight miles of the base.

By dispersing individual missile launchers so that they are separated by a distance greater than the blast-damage radius of a large megaton warhead, an enemy is forced to launch two or more missiles to be sure of destroying each of the U. S. missile.

F8U-3 Assignment

Washington—Chance Vought F8U-3 fighters completed before the Navy program was canceled will be used by National Aeronautics and Space Administration in supersonic transport research. Basic work will be done with the highly automated control system in the aircraft. NASA will have two F8U-3s at Langley Research Center and one at Ames Research Center.

GE to Develop 212L Air Defense System

Syracuse, N. Y. — Air Force has awarded the contract for development of its Air Weapons Control System 212L, the "little SAGE" system for fixed and mobile air defense applications outside the continental United States, to General Electric's Heavy Military Electronics Department.

The 212L system is to be designed to be capable of providing air control for situations ranging from defense of a single airfield to defense of an area the size of a continent. This flexibility would be attained by providing for the interconnection and cross telling of data between separate systems in the same manner as the SAGE (Semi-Automatic Ground Environment) system employed for air defense within the United States.

Medium-Range Turbofan

Cincinnati—New turbofan engine for short to medium-range jet transports designated the CJ-810 has been added to General Electric's commercial jet engine series. Engine will be in the 7,000 to 9,000 lb. thrust class and will be essentially a scaled-down version of the CJ-805-23 aft fan development of the CJ-805 conventional turbojet.

All of these engines are based upon the J79 and use the variable stator system pioneered by that turbojet. The fan section of the CJ-810 will be single stage and driven by the last stage turbine.

Boeing, Convair and Douglas are among the airframe companies considering medium-range transports which probably would employ an engine in the thrust class.

Aircraft Firms Detail Salaries, Bonuses

Washington—Following is a list of aircraft company officers' and directors' salaries and stock holdings for 1958 as filed with the Securities and Exchange Commission:

Bendix Aviation Corp.—Fiscal year 1958 ending Sept. 30, 1958. **M. P. Ferguson,** president and director, $164,249.96 salary and 2,073 shares of common stock; **A. P. Fontaine,** vice president and director, $58,749.97 salary and 587 shares of common stock; **E. K. Foster,** vice president and director, $77,249.92 salary and 630 shares of common stock; **W. M. Houghton,** vice president, treasurer and director, $90,000.00 salary and 5,383 shares of common stock; **R. P. Lansing,** vice president and director, $94,800.00 salary and 4,456 shares of common stock; **C. Marcus,** vice president and director, $101,900.00 salary and 225 shares of common stock; **L. F. Polk,** president of Sheffield Corp., a subsidiary of Bendix, and director, $67,908.00 salary and 22,800 shares of common stock; **G. E. Stoll,** vice president and director, $97,499.96 salary and 6,046 shares of common stock; **C. C. Tillinghast, Jr.,** vice president and director, $42,999.96 salary and 221 shares of common.

Following directors were not paid a salary: **H. B. Baker,** 2,247 shares of common stock; **J. D. Biggers,** 225 shares of common stock; **C. Francis,** 210 shares of common stock; **E. Kanzler,** 1,124 shares of common stock; **C. S. H. Mott,** no stock; **E. B. Palmer,** 898 shares of common stock.

Boeing Airplane Co.—**W. M. Allen,** president and director, $135,166 salary and 12,315 shares of common stock; **W. E. Beall,** senior vice president and director, $88,467 salary and 5,200 shares of common stock; **F. P. Laudan,** vice president-manufacturing and director, $45,600 salary, 8,725 common shares and $20,000 worth of 4½% convertible subordinate debentures; **J. E. Schaefer,** vice chairman of the board and director, $32,200 salary and 1,574 shares of common stock; **E. C. Wells,** vice president-engineering and director, $73,653 salary and 3,552 shares of common stock; **J. O. Yeasting,** vice president-finance, comptroller and director, $56,658 salary and 2,985 shares of common stock.

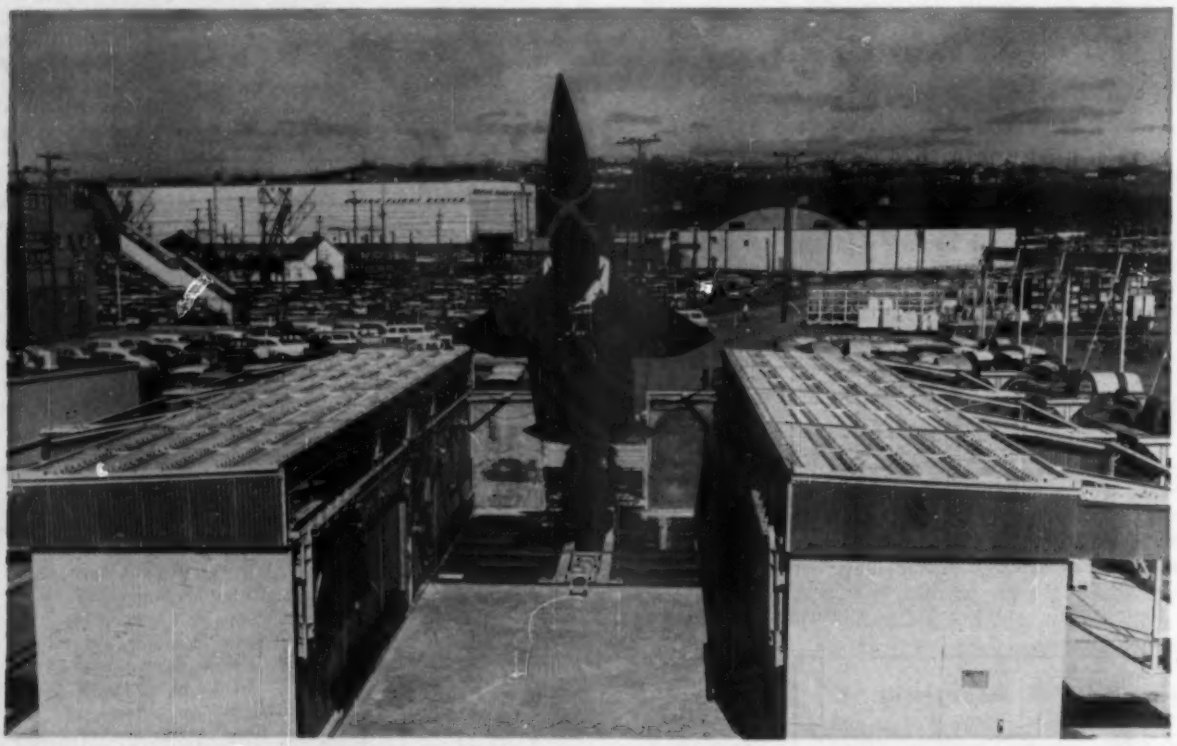
Following directors were not paid a salary: **D. Corbet,** 661 common shares and $2,700 worth of 4½% convertible subordinate debentures; **C. L. Egtvedt,** chairman of the board, 18,528 shares of common stock; **D. A. Forward,** 520 common shares and $2,200 worth of 4½% convertible subordinate debentures; **A. L. Gates,** 324 shares of common stock; **W. G. Reed,** 1,418 shares of common stock; **D. Schmitz,** 6,000 shares of common stock.

Chance Vought Aircraft, Inc.—**C. J. McCarthy,** chairman of the board and director, $76,799.92 salary and 2,000 shares of common stock; **F. O. Detweiler,** president and director, $106,583.31 salary and 1,500 shares of common stock; **R. C. Blaylock,** vice president, general manager and director, $59,275.00 salary and 750 shares of common stock; **H. B. Sallada,** senior vice president and director, $62,299.84 salary and 1,500 shares of common stock; **C. E. Burt,** vice president-finance and director, $54,566.53 salary and 600 shares of common stock; **G. K. Johnson,** vice president and director, $52,783.22 salary and 50 shares of common stock.

Following directors were not paid a salary; **D. A. Huley,** 100 shares of common stock; **L. F. McCollum,** 400 shares of common stock; **J. E. Mitchell, Jr.,** 50 shares of common stock; **W. W. Overton, Jr.,** 500 shares of common stock; **D. L. Simmons,** 100 shares of common stock; **B. L. Taylor,** 100 shares of common stock; **J. R. Wood,** 200 shares of common stock.

Curtiss-Wright Corp.—**R. T. Hurley,** chairman of the board, president and director, $324,400 salary, $150,000 bonus and 15,500 shares of common stock; **G. B. Hill,** executive vice president, vice president-finance and director, $166,400 salary, $90,000 bonus and 12,000 shares of common stock; **J. G. Byron,** executive vice president and director, $83,867 salary, $55,000 bonus and 3,700 shares of common stock; **J. V. Miccio,** vice president and general manager of the Wright Aeronautical Division, $110,200 salary and stock not listed.

Following directors were not paid a sal-



Boeing Bomarc B Mounted in Prototype Shelter

Boeing Bomarc B surface-to-air interceptor missile, advanced version of the IM-99 weapon now in production, is mounted in a new tactical launching shelter at Boeing Airplane Co.'s Pilotless Aircraft Division, Seattle, Wash. Bomarc B is being built for USAF's Air Defense Command and for the Canadian government (AW May 11, p. 72). Missile has a Thiokol solid propellant boost rocket; cruise propulsion will be delivered by two Marquardt RJ43-MA-7 ramjets. Company said Bomarc B range has been increased from 250 to 400 mi. and defense area increased to more than 500,000 sq. mi. Prototype shelter shown here is 60 ft. long, 20 ft. wide and 12 ft. high and is constructed of precast reinforced concrete slabs and prefabricated steel I-beams. Two sections can be opened automatically in 3 sec. At least two bases will have 56 such shelters to house a full squadron of missiles; others will be equipped with 28 each. Shelter normally is unmanned; button from a SAGE (Semi-Automatic Ground Environment) center opens the roof and programs the firing.

ary: **T. B. Berner**, 1,200 shares of common stock; **L. H. Campbell, Jr.**, 100 shares of common stock; **J. C. Cowdin**, 100 shares of common stock; **L. R. Crandall**, 500 shares of common stock; **C. A. Dana**, 100 shares of common stock; **D. C. Power**, 100 shares of common stock; **S. R. Reed**, 300 shares of common stock; **L. H. Smith**, 9,000 shares of common stock; **H. S. Sturgis**, 500 shares of common stock.

Douglas Aircraft Co., Inc.—**F. W. Conant**, vice chairman of the board, senior vice president and director, $100,800 salary and 1,122 shares of common stock; **D. W. Douglas**, chairman of the board and director, $151,000 salary and 15,450 shares of common stock; **D. W. Douglas, Jr.**, president and director, $82,250 salary and 1,082 shares of common stock; **J. A. Dundas**, executive vice president and director, $57,000 salary and 824 shares of common stock; **F. E. Hines**, vice president and director (resigned Oct. 22, 1958), $37,587 salary with no stock; **N. Paschall**, vice president and director, $50,600 salary and 1,158 shares of common stock; **A. E. Raymond**, senior vice president and director, $76,705 salary and 10,866 shares of common stock.

Following directors were not paid a salary: **M. W. Bekins**, 618 shares of common stock; **G. E. Donovan**, 400 shares of common stock; **I. C. Eaker**, no stock; **C. S. Jones**, no stock; **C. J. Lick**, 618 shares of common stock; **G. Mayo**, no stock; **E. H. McLaughlin**, 2,000 shares of common stock; **N. Petree**, 154 shares of common stock; **S. G. Welsh**, 3,863 shares of common stock; **D. Whiting**, 618 shares of common stock.

Fairchild Airplane & Engine Corp.—**R. S. Bontelle**, president and director, $116,065 salary and 2,600 shares of common stock; **A. B. Flood**, executive vice president, comptroller and director, $38,972 salary and no stock; **W. L. Landers**, vice president, $75,473 and no stock listed; **F. E. Newbold, Jr.**, vice president and director, $50,253 salary and 110 shares of common stock.

Following directors were not paid a salary: **J. A. Ailis**, 2,600 shares of common stock; **J. H. Carmichael**, 100 shares of common stock; **R. B. Carney**, 105 shares of common stock; **C. H. Colvin**, 263 shares of common stock; **E. Cook**, 105 shares of common stock; **C. L. De Orsey**, 15,000 shares of common stock; **S. M. Fairchild**, chairman of the board, 100,559 shares of common stock; **W. P. Lane, Jr.**, 4,000 shares of common stock; **G. Loening**, 3,000 shares of common stock; **R. S. Stillman**, 100 shares of common stock.

General Electric Co.—**R. J. Cordiner**, chairman of the board of directors and director, $279,974 salary, 1,988 shares in stock bonus and 41,602 shares of common stock of which 29,972 are held in contingent interest; **R. Paxton**, president and director, $200,014 salary, 1,242 shares in stock bonus and 30,356 shares of common stock of which 9,034 are held in contingent interest; **P. D. Reed**, chairman of the finance committee and director, 180,014 salary, 1,24[illegible] shares in stock bonus and 35,893 shares of common stock of which 26,893 are held in contingent interest.

Following directors were not paid a salary: **S. S. Colt**, 3,170 shares of common stock; **D. K. David**, 600 shares of common stock; **C. S. Dickey**, 9,000 shares of common stock; **H. Ford II**, 100 shares of common stock; **J. Holmes**, 1,000 shares of common stock; **F. L. Hovde**, 10 shares of common stock; **G. W. Humphrey**, 100 shares of common stock; **J. E. Lawrence**, 100 shares of common stock; **G. H. Love**, 600 shares of common stock; **T. B. McCabe**, 2,500 shares of common stock; **G. G. Montgomery**, 1,100 shares of common stock; **H. S. Morgan**, 9,000 shares of common stock; **R. T. Stevens**, 500 shares of common stock; **S. J. Weinberg**, 1,500 shares of common stock; **R. W. Woodruff**, 1,590 shares of common stock.

Grumman Aircraft Engineering Corp.—**L. R. Grumman**, chairman of the board, $50,250 salary and 138,420 shares of common stock; **L. A. Swirbul**, president and director, $100,300 salary and 10,500 shares of common stock; **W. T. Schwendler**, senior vice president and director, $50,300 salary and 49,400 shares of common stock; **E. C. Towl**, vice president and director, $47,800 salary and 3,000 shares of common stock; **E. W. Poor**, treasurer, salary not listed with 34,090 shares of common stock; **A. P. Loening**, director, no salary with 35,000 shares of common stock; **C. A. Wight**, director, no salary with 1,000 shares of common stock.

Hiller Aircraft Corp.—**D. W. Elam**, vice president, $32,437.43 salary; **Pedder, Ferguson & Pedder**, legal services, $15,995.

Following directors were not listed as receiving a salary: **S. Hiller, Jr.**, 100,000 beneficially owned shares of common stock; **W. A. Blees**, 50 beneficially owned shares of common stock; **E. T. Bolton**, 200 beneficially owned shares of common stock; **F. A. Callery**, 1,000 beneficially owned shares of common stock; **A. J. M. Chadwick**, 100 beneficially owned shares of common stock; **K. Ferguson**, 500 beneficially owned common shares and $10,000 worth of 5% Con. Income Debentures; **P. M. Hamilton**, 100 beneficially owned shares of common stock; **S. Hiller, Sr.**, 5,838 beneficially owned shares of common stock; **F. A. Heileman**, $4,000 worth of Con. Income Debentures.

M. E. McAlpin, 1,100 beneficially owned common shares and, as of Feb. 9, 1959, Mrs. McAlpin owned $10,000 in Con. Income Debentures, McAlpin a trustee under a trust beneficially holding $81,000 in Con. Income Debentures and McAlpin a trustee under a trust but not beneficially holding $100,000 in Con. Income Debentures; **H. L. McIntyre**, 50 beneficially owned common shares, $1,000 worth of Con. Income Debentures directly held—as of Feb. 9, 1959, McIntyre was a trustee under a trust with no beneficial interest but with Mrs. McIntyre a beneficial holder in $150,000 in Con. Income Debentures; **A. W. B. Vincent**, 13,303 beneficially owned common shares and $50,000 worth of Con. Income Debentures directly held.

The Martin Co.—**G. M. Bunker**, president and chairman of the board, $150,000 salary and 77,344 shares of common stock; **W. B. Bergen**, executive vice president and director, $86,666 salary and 8,276 shares of common stock; **C. W. Miles**, general counsel and director, $75,000 salary and 150 shares of common stock; **E. G. Uhl**, vice president, $53,333 salary and no stock listed.

Following directors were not paid a salary: **H. Bruce**, 4,730 shares of common stock; **W. A. Burns, Jr.**, 200 shares of common stock; **J. E. Parker**, 2,000 shares of common stock; **E. H. Pixley**, 122 shares of common stock; **A. B. Royce**, 242 shares of common stock; **F. F. Russell**, 35,000 common shares of common stock owned by National Aviation Corp., of which Russell is chairman of the executive committee and a director; **D. M. Spencer**, 1,103 shares of common stock; **J. L. Sullivan**, 9,702 shares of common stock.

GE T58 Nears End of Endurance Test

By Robert H. Cook

Washington—General Electric T58 turboshaft engine is expected to complete a 1,000 hr. endurance test with no major replacement of parts based upon its current deterioration rate of only 2%, it was reported here last week at the Fifteenth Annual National Forum of the American Helicopter Society.

Coulman Wescott, Jr., supervisor of service engineering on T58, told AHS delegates that the conclusion of the 1,000 hr. of endurance testing will represent 2,000 typical helicopter missions.

Low Deterioration

Attainment of the very low deterioration rate on the engine, he said, was realized after a 900 hr. inspection representing completion of 1,800 starts, 3,600 burst accelerations and various other endurance tests.

Wescott's progress report on the development and testing of the T58 was among those presented at the meeting. Others included reports on the operational costs of the Fairey Rotodyne and on commercial operations in Alaska utilizing Bell 47G-2 helicopters.

Light weight of the T58 (267 lb.) plus its design for ease of field maintenance is expected to give the engine several advantages over heavier aircraft gas turbines, Wescott said. As an example, he said engine installation or removal can be accomplished easily by two men in less than one hour, while the T58's light weight recently permitted two men to load it into a station wagon for return to the factory, thus accelerating field service.

Minor inspection of the T58 now stands at 30 hr. and consists of a preflight inspection plus visual check of oil and fuel filters, magnetic drain plugs and engine mounts.

Major inspection, now set for 60 hr., primarily concerns the hot section of the engine and is performed with the engine removed. It repeats the minor inspection plus:

- **Removal of one half of compressor** casing, inspection of stator and rotor.
- **Removal and inspection of turbine** wheel and nozzle diaphragms.
- **Removal of combustor casing half** for combustor check.
- **Check of fuel nozzles.**
- **Partial disassembly of power turbine** for check of buckets, wheel, worm gear and sleeve and polygon spline.
- **Inspection of No. 3 gas generator** bearings and No. 4 and 5 power turbine bearings.

Field Inspection

Field inspections also have shown the need for design refinements to further simplify maintenance and improve reliability and performance.

Wescott said the following items are currently being incorporated into the engine:

- **Increase in combustion liner life** through an improved method of mounting to ease installation and ensure positive location of the liner in relation to outer casing. Liner life has been extended from 25 hr. on early engines to the present point which exceeds the allowable overhaul life with a liner

Helicopter Society Elections, Awards

Washington—Ralph P. Alex, head of Sikorsky Aircraft's production design components section and first president of the American Helicopter Society in 1944-45, was elected to head the organization in 1959 during the AHS Fifteenth Annual National Forum here.

National secretary during the year is Robert L. Suggs, president of Petroleum Helicopters, Inc. Jack M. Cherne, director of engineering of Vard, Inc., was elected treasurer.

Regional vice presidents elected were John E. Ryan, New England; George M. Powell, Jr., Mideast; Henry Detrich, Southeast; Alan A. Lischer, Midwest; Myron Kawa, Southwest and Fred M. Milam, West.

Highest honor bestowed by the Society, the Dr. Alexander Klemin Award, was awarded to Robert L. Lichten, of Bell Helicopter Corp., for development of the Army XV-3 Convertiplane.

Honorary fellowships were awarded Brig. Gen. William B. Bunker, commander of the Army Transportation, Supply and Maintenance Command, and Carlyle C. Agar, former president and founder of Okanagan Helicopter Ltd., of Vancouver.

New York Airways received the Society's Kossler Award in recognition of the "most outstanding practical application of the helicopter." Engineers of Vertol Aircraft Co. received the Grover E. Bell Award for the design, development and successful test flight of the tilt-wing Vertol 76.

life of 1,000 or more hours expected.

• **Quick attach-detach cam-lock** fitting has been installed between the fuel control and pump and will reduce time required to replace a fuel control from 3 to less than 1 man hour.

• **Addition of a centrifugal filter** as added protection when operating with contaminated fuel. Utilizing this filter, General Electric has completed more than 1,700 hr. of factory evaluation and has successfully qualified the T58 on fuel contaminated with lint, iron oxide, road dust and salt water.

• **Ignition system** has been changed by adding a second ignitor, permitting starting capabilities from −65F to 130F with JP-4 fuel and consistent starts at −20F with JP-5.

Wescott added that no flight has been aborted because of T58 engine difficulties. On the first flight test engine, he said, unscheduled removals occurred on an average of one every 30 hr. as compared with the current figure which is in excess of 130 hr.

Low operational cost of the Fairey Rotodyne was emphasized by G. S. Hislop, chief engineer of Fairey Aviation Co. Size, speed, low cruise fuel consumption and simplification of the rotor power transmission on the Rotodyne has produced operating costs at a level with those of the latest fixed wing aircraft operating on the same stage lengths, Hislop said.

A compound helicopter equipped in its prototype form with two Napier Eland turbine engines, the Rotodyne's direct operating cost per seat mile approximates the four cent figure for the four-engine Vickers Viscount turboprop airliner on a 250-mi. stage length, as compared with 23 cents for present helicopters and 15 cents per seat mile for turbine-powered helicopters, according to Hislop. More recent studies indicate the feasibility of attaining a cruise speed of 220 kt. or more with the Rotodyne with a further reduction of operational costs and a doubling of the aircraft's present range of 250 naut. mi., he said.

Rotor head and blades of the Rotodyne, made of steel with a low fatigue stress level, are expected to have a virtually infinite fatigue life, since, during cruise operation, the rotor is largely unloaded and stresses are low, Hislop told the meeting.

Transport productivity of the Rotodyne per pound of empty weight and per pound of fuel versus range also indicates that the aircraft is six to eight times more economical than the helicopter, the Fairey official said. At its present range of 250 mi., Hislop said, the Rotodyne will provide .06 ton-knots per pound of empty weight as compared with .01 for the helicopter. The aircraft also will produce .3 ton-knots per pound of fuel as compared to less than .05 for the helicopter.

Problems encountered in a summer long survey of portions of Alaska utilizing a fleet of four Bell 47G-2 helicopters were reported by Link Luckett, senior pilot of Petroleum Helicopters, Inc. Conducted for the U. S. Geological Survey, the expedition took place in three separate areas including the fjord territory of southeastern Alaska, the mountainous terrain around Mt. McKinley and the Seward Peninsula area north to the Arctic Ocean.

In the first area, mountains rise to a 7,000 ft. elevation, with the helicopters often forced to circle and cut back in order to reach and land survey teams on mountain tops, Luckett said. Low lying clouds, extreme temperature inversions and dense fog were daily flight hazards in this area. Float-type landing gear was selected for this area since emergency landing could be made only on water or a mountain top.

While floats worked well as all-purpose gear on snow, tundra and boulders, air pressure leakage and blow-outs of older gear became a problem at higher altitudes, he said.

Jagged boulders on the 9,000-ft. high peaks of the Aleutian range constituted the only hazard to rotor blades in this area, while constant rain and fog and snow in the late season hampered operations in the far north sectors. However, only 6-to-10 days were lost in the latter section, and the long daylight hours permitted an almost around-the-clock operation, Luckett said.

Heavy dust conditions in one area, cold weather and heavy insect swarms about the tent camp maintenance bases combined to create maintenance problems. However, Luckett said that, in spite of the elevations being gained, it was never necessary to strip down the helicopters.

In the far north sectors operating over rolling hills and tundra flats, gas and oil was delivered by barge up the Yukon River. For longer trips, the pilot put out his own caches of canned gas. On most flights, no radio was used since there was no active base to contact after geologists were flown out in the morning, Luckett said.

General Dynamics' Sales, Earnings Drop

First quarter sales and earnings of both General Dynamics Corp. and United Aircraft Corp. were down from last year and for the same reason—increased research and development costs.

General Dynamics wrote off $8,816,559 in expenses on the Convair 880/600 jet transport program compared with $4,308,338 in the first quarter of 1958. It said that for 1959 these expenses will substantially exceed the $24,012,620 total for last year. The company told stockholders these large expenses were essential if the company is to participate in the jet age.

United Aircraft said only there were substantial research and development expenses on non military-supported programs. Coupled with a lower sales volume, this reduced the company's first quarter sales to $250,279,610 compared with $308,847,101 last year and earnings from $11,543,934 or $1.75 a share to $8,033,515 or $1.20 a share this year. Backlog fell slightly from $1,400 million a year ago to $1,300 million.

Backlog for General Dynamics was up from $1,774 million a year ago to $2,090 million. First quarter sales declined from $386,419,273 to $330,633,782 and earnings from $9,872,366

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or $1.01 a share a year ago to $5,925,385 or 60 cents a share.

The company noted in the report that USAF has issued a letter contract for procurement of long lead time items for 40 B-58 bombers in addition to the 66 ordered to date.

Other financial reports:

• **Marquardt Aircraft Co.** in its 1958 annual report noted continued growth. Sales rose from $41,620,400 in 1957 to $49,691,600 last year and earnings from $1,036,000 or $1.62 a share in 1957 to $1,131,300 or $1.74 a share for 1958. The report added that Olin Mathieson Chemical Corp., which had owned approximately 25% of Marquardt's capital stock had sold 75% of this interest in a private placement. Two Olin Mathieson representatives on the board resigned along with this move. Olin has been selling its interest in various other companies and the move did not relate to Marquardt's progress. Marquardt's backlog as of Mar. 31, 1959 was $89,778,000—a new high.

• **Grumman Aircraft Engineering Corp.** first quarter earnings were $1,051,283, up from the $615,489 reported for the same quarter last year. Sales for the period increased $7.6 million over the $53,124,474 reached in the first quarter of 1958. Backlog as of Mar. 31 was $360 million, an increase of $100 million over the backlog reported in March, 1958.

Space Technology

Interplanetary Shock Waves Simulated in Avco Shock Tube

Everett, Mass.—Interplanetary shock waves that travel from the sun to the earth at velocities in excess of 1,000,000 mph. have been reproduced in a laboratory shock tube in experiments that may have application both to research on controlled thermonuclear power and for space vehicle propulsion.

These interplanetary shock waves which originate with the streams of charged particles ejected by solar flares have been used to expiain theoretically the sudden onset of magnetic storms simultaneously around the earth after solar disturbances. They existed in theory only, however, until the shock tube experiments proved that a sharply defined shock wave could be propagated through as rarified a gas as the tenuous interplanetary atmosphere.

The experiments were conducted at the Everett Research Laboratory of the Avco Corp. Results were announced last week in connection with the dedication of the corporation's new research center in Wilmington, Mass. The new facility will house Avco's Research and Advanced Development Division.

The high velocity shock wave was produced by the electrical discharge of four billion watts in a 30 in. shock tube developed by physicist Dr. Richard Patrick under the guidance of Dr. Arthur Kantrowitz, director of the laboratory and a recognized authority on high temperature gas dynamics and shock tube technology. Part of the research program has been supported by the Air Force Office of Scientific Research.

In discussing the results of the experiments, Dr. Kantrowitz pointed out that the findings of Pioneer IV demonstrated that magnetic storms associated with interplanetary shock waves also result in great increases in intensity of the outer Van Allen radiation belt. These "magnetic typhoons," he said, may constitute "an important radiation hazard for manned space flight, and the understanding of these dramatic events will be as important for astronauts as the understanding of terrestrial weather has been for mariners and aviators."

Solar shockwaves striking a manned space vehicle would not affect the vehicle or its personnel, but would have the effect of "combing out" discontinuties in the sun's magnetic field and make a path for much higher energy particles to follow. The result would be that dangerous levels of radiation would exist in the wake of a solar shock wave for one or two days.

Although the temperatures produced in the laboratory shock tube did not exceed two million degrees, Dr. Kantrowitz believes that continuing exploration of this technique can contribute significant knowledge leading to the development of a controlled fusion reactor.

Also, the capability of the shock tube of generating shock waves with velocities greater than one million miles per hour may assist in the development of propulsion systems for space vehicles.

A point of fundamental physical significance is that the experiments resulted in the creation of a shock wave whose thickness was less than the mean free path of the gas which was heated by the shock wave. This is contrary to the well-known concept of energy transfer through a gas such as takes place in propagation of aerodynamic or acoustic shock waves where energy is transferred by colliding of air molecules.

At sea level the number of particles or air molecules is large enough (2.6×10^{19} per cu. cm.) so that energy transfer by collision is effective. The mean free path—the average distance a particle travels before colliding with another particle—at sea level is only about 10^{-5} cm. Interplanetary gas, however, presents an entirely different situation.

In the solar system there are approximately 10^{5} to 10^{8} particles per cu. cm. These particles are in the form of an ionized plasma—that is, there are approximately equal numbers of protons (hydrogen nuclei) and electrons. The mean free path of these particles is in the order of 10^{11} cm. Under the conventional theory of energy transfer by collision, it is not possible to explain how a shock wave could be transmitted through this atmosphere.

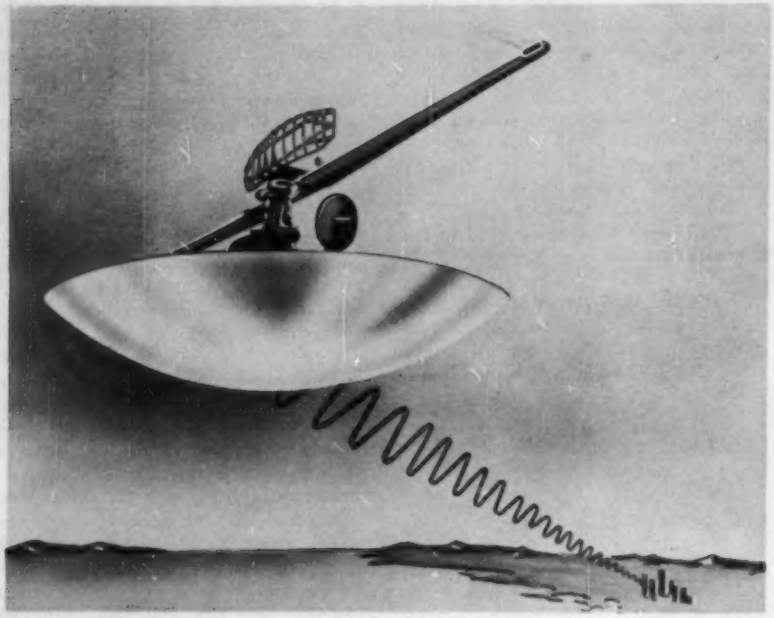
A theory as to how the concept of interplanetary shock waves could explain magnetic phenomena otherwise unexplainable, and as to how they were propagated through the tenuous gas between the sun and the earth, was first proposed at a meeting on the Dynamics of Cosmical Clouds in Cambridge, England, in 1953.

Dr. Kantrowitz who was at that time a professor at Cornell University, delivered a paper on shock waves that had been studied in shock tubes. In the discussion that followed the paper, Prof. Thomas Gold, at that time Chief Assistant to the Astronomer Royal in Great Britain but at Harvard University at present, pointed out that the suddenness of a shock wave would explain how some of the magnetic storms appearing to originate with solar flares began with great suddenness simultaneously all over the earth. This "sudden commencement" was in the order of one or two minutes. The previous theory of corpuscular radiation would result in a time of onset of magnetic storm of an hour or more.

Because there were too few particles between the sun and earth for propagation of classical shock waves, a new propagating mechanism presumably involving electromagnetic fields was strongly indicated. Shortly after this, Drs. Richard Patrick and G. S. Janes began attempting to produce such waves at the Avco Research Laboratory.

The technique used was to create a strong magnetic field in a confined space with the use of a bank of condensors. Magnetic fields tend to expand in the same manner as compressed gases. By confining the field in all directions but one, it was free to push highly rarified hydrogen in the only remaining direction.

In this way, the rarified hydrogen was accelerated to velocities in excess of 1 million mph., approaching the velocities of gas in solar flares.



RADIO ENERGY would power this pilotless helicopter, shown hovering above the earth in a fixed position in a Raytheon artist's conception. Helicopter would carry an airborne search radar or infrared system for early warning mission.

Radio-Energy-Powered Helicopter Proposed to USAF by Raytheon

Washington — Pilotless helicopter powered by radio energy beamed from ground or shipboard transmitters, enabling the helicopter to remain airborne continuously for weeks at a time for airborne early warning or communications relay purposes, has been proposed to the Air Force by Raytheon Manufacturing Co.

Air Force is expected to award Raytheon a Phase I study contract for the radically new concept in airborne radio-powered vehicles—an idea conceived by company scientists. Preliminary company studies indicate that radio-powered hovering vehicles of this type would be considerably more economical than conventional AEW&C aircraft for airborne early warning.

Raytheon's unsolicited proposal for a radio-powered early warning helicopter arrived at the time Air Force was evaluating bids for new early warning aircraft and is believed to have been one of the reasons for USAF action in deferring decision on proceeding with that program (AW Feb. 2, p. 23).

The helicopter would be large enough to carry an airborne search radar or infrared system for early warning plus associated radio equipment to transmit target information back to the ground. Vehicle also could be outfitted with radio receiver and transmitter or reflecting surface and used as a communications relay station similar to proposed communication satellites.

The helicopter rotors would be driven by rotortip jets using hot air obtained by converting radio energy beamed from the ground into heat. Conventional fuel would be used to power the helicopter during takeoff and climb to hovering altitude, with radio energy used only to sustain it at hovering altitude. The vehicle might carry a modest amount of fuel aboard to cope with emergency loss of ground power.

Such a radio-powered helicopter has been made possible by the extremely high-power transmitting tubes developed for long-range radars. Some of these tubes have peak powers in the tens of megawatts range, with average power levels of more than 100 kw. (134 hp.). Recently devised techniques make it possible to operate a number of these tubes in parallel so that hundreds of horsepower can be generated on the ground at radio frequencies.

By using a large ground or shipboard transmitting antenna and a medium-size receiving antenna aboard the helicopter, a moderate per cent of the energy generated on the ground can be received by the vehicle. A small portion of this electrical power will be used for airborne avionics equipment; the remainder will be converted to heat to power the helicopter rotor jets.

Liquid Hydrogen Being Produced for Rockets

Quantity production of liquid hydrogen for rocket development and static firings of liquid hydrogen/liquid oxygen rockets at thrust levels in excess of 100,000 lb. was revealed last week.

Lt. Gen. Bernard A. Schriever, commander, Air Research and Development Command, told an Institute of Aeronautical Sciences meeting at Denver that the high energy propellant is in production by the Stearns-Roger Mfg. Co. at Bakersfield, Calif., and by Air Products, Inc., at Painesville, Ohio, and West Palm Beach, Fla. The California and Ohio plants have been operating for over a year, and the large tonnage Florida plant has been on-stream for three months.

Dr. J. C. Moise, head of preliminary design at Aerojet-General's liquid rocket plant told the Aviation Writers Assn. in Washington, D. C., that his company tested the 100,000 lb. thrust liquid hydrogen fueled rockets this past year under Wright Air Development Center sponsorship.

The Air Products production facilities are known as the Bear series, with Mama and Papa Bear being in West Palm Beach and Baby Bear representing the Painesville facility. A future liquid hydrogen producer will be the Linde Co. which was awarded a contract by the National Aeronautical and Space Administration for the production of the material at Torrance, Calif. (AW April 13, p. 35).

One estimate of production costs put the figure at about $1.00 per pound.

Liquid hydrogen has an energy content of almost three times that of present liquid fuels. Liquid hydrogen/liquid oxygen propellants, slated to power the second stage of the Convair Centaur rocket, are capable of nearly 40% more thrust in relation to propellant expended than present fuels. Dr. Moise said that liquid hydrogen instead of kerosene in the Titan ICBM second stage would double the payload and cut payload delivery cost in half. He emphasized, however, that the fuel's low density indicated a greater potential for use in upper stages.

Another rocket application of liquid hydrogen mentioned by Dr. Moise and outlined in AVIATION WEEK (May 4, p. 85) is as the working fluid in a nuclear-powered rocket.

The chief obstacles to volume production of liquid hydrogen have been achieving low temperatures for its liquefaction (−420F) and its rather high reactivity.

The key to efficient refrigeration to large gas volumes at West Palm Beach was the development of turbo-expanders which extract heat from the gas. Ex-

panders are free turning, as any benefits gained by harnessing the turbines—which reach rotational speeds of 200,000 rpm.—are more than offset by the mechanical problems involved.

News Digest

Air Force and Navy awarded Beech Aircraft Corp. a development contract last week for a low-cost Mach 2 target drone. KD2B-1 target will be designed to fly at any altitude between 5,000 and 70,000 ft., and its flight duration will range from five minutes at Mach 2 to eight minutes at Mach 1.5. Scheduled to be operational in 1962, the drone will have a scoring and self-destruct system.

Photographs of the six-inch-diameter Vanguard I have been taken when the satellite was at its apogee 2,500-mi. from the earth by a Baker-Nunn tracking camera located at the Woomera Missile Range in Australia. Successful photographs have been made on three different occasions—May 1, 3 and 4—according to NASA.

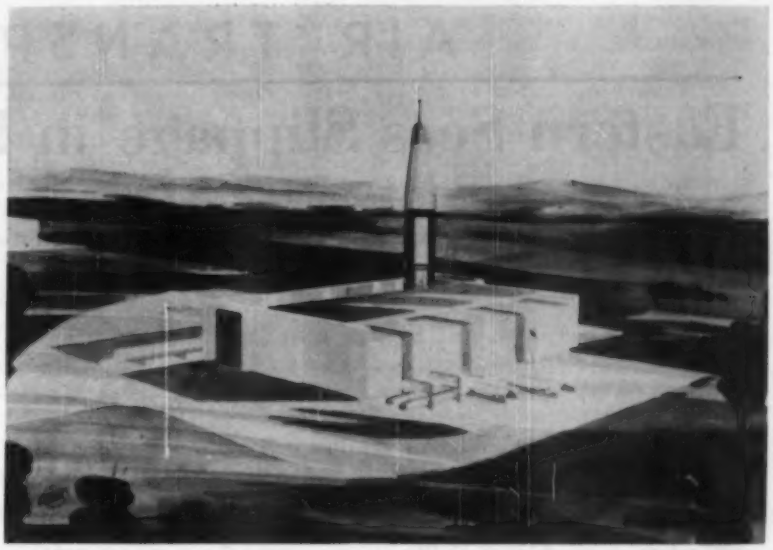
Whitley C. Collins, president of Northrop Corp., died last week from a circulatory disorder. He was 61 years of age. Collins was president and chief executive officer of Northrop since 1954.

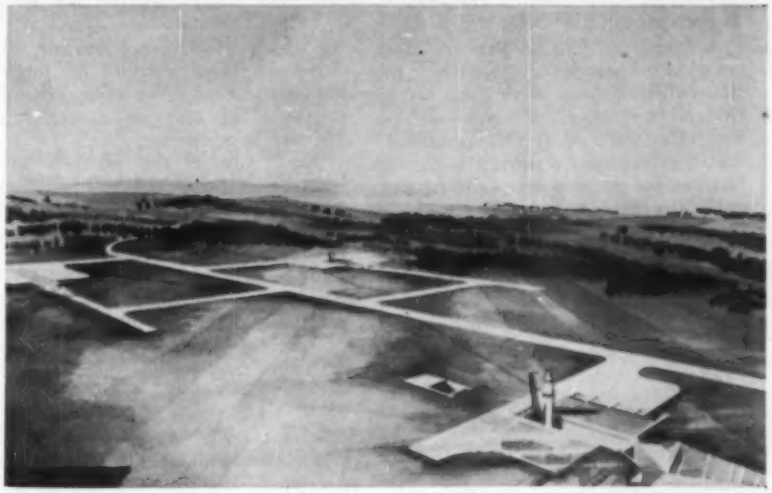
Allison Division of General Motors announced last week that it has a development contract for first and second-stage rocket motor cases for the Air Force Minuteman multi-range ballistic missile under a joint program with Thiokol Chemical Corp.

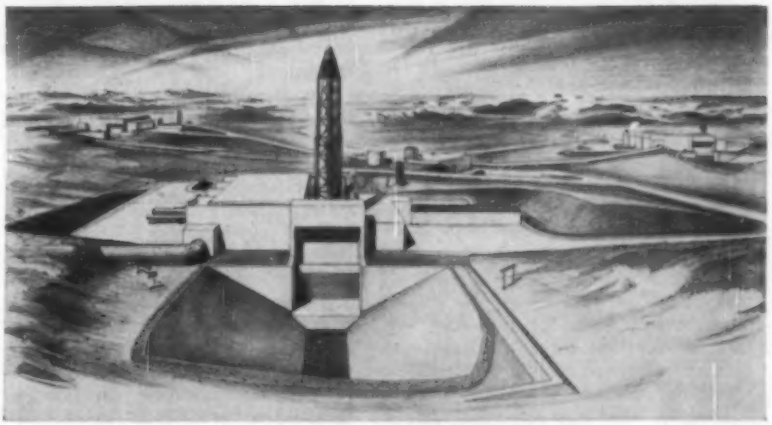
Funeral services for Deputy Defense Secretary Donald A. Quarles were held last week in Washington. Quarles, 64, died May 8 of a heart seizure. First coming to the Pentagon in September of 1953 as Assistant Secretary of Defense for Research and Development, Quarles served as Secretary of the Air Force from August, 1955, until his appointment as Deputy Defense Secretary in March, 1957.

RVX-1 Ablation

The RVX-1 materials research re-entry vehicle that on April 8 was recovered from the South Atlantic after 5,000 naut. mi. flight was, according to Lt. Gen. Bernard A. Schriever, completely successful. Total ablation of the approximately 700 lb. vehicle was a very small part of its weight. Much of the material that ablated from the nose was observed to flow back and be deposited on the cylinder. Aerodynamic stability was not adversely affected.







Atlas Hardened Bases

Two versions of hardened launching complexes for the Air Force Convair Atlas ICBM are shown in the artist's conceptions above. The upper and lower drawings shown above-ground reinforced concrete installations. The missile is raised out of the main building before fueling. Blast pit for the rocket exhaust is show at bottom. Sunken access road and blast tunnel for the underground complex is illustrated in the center drawing.

Eastern Sees Slippage in DC-8 Delivery

Training program is geared to meet revised date of November, but plan is termed 'highly optimistic.'

By L. L. Doty

Miami Beach—Eastern Air Lines has geared its training program for its Douglas DC-8 jet transport fleet to meet a revised delivery date of November, although it now feels that chances are small that any of the aircraft will arrive before the original January contract date.

During the company's Advisory and Junior Board meeting (AW May 11, p. 37), which concluded here last week, strong doubt was expressed that the airline could enter the turbojet race before the beginning of the year. Under the terms of its lease with Pan American, National Airlines—chief competitor to Eastern on the New York-Miami route—will resume Boeing 707 service in December (AW Sept. 15, p. 38).

According to Charles Froesch, Eastern's vice president-engineering, the ahead-of-schedule delivery dates set by Douglas now appear "highly optimistic." He also said it was "doubtful" that the projected certification date of October for the airplane would be met.

Key as to how close Douglas will come in meeting its up-dated schedule is United Air Lines, Froesch told the group. He said that if United receives its first Douglas DC-8 by June 1—the revised delivery date for this carrier—then Eastern had a "good chance" of receiving its first turbojet in November.

However, he questioned Douglas' ability to meet the June 1 date and said that the manufacturer may be from "three weeks to two months" behind schedule.

Eastern, he said, could expect approximately the same delivery delays that United may experience.

Original Contract

Under the terms of the original contract, Eastern was to have received its first two DC-8s in January, 1960. The revised schedule calls for delivery of one airplane each in November, December and January.

United, under the revamped delivery program, is scheduled to accept the first aircraft on June 1 and the second on June 15. Delta, next in line, will take delivery of three airplanes—one each in July, August and September—under the schedule.

Douglas now has seven aircraft in test programs, with the first DC-8 showing a log of an accumulated 200 hr. Two aircraft are being used for certification tests.

Discussion of the DC-8 program is typical of the wide-range of subject matter injected into the six-day meeting which is held twice annually. The Advisory Board consists of top-level management and the Junior Board is composed of assistant managers and assistant supervisors.

Next month, the advisory group meets with the Field Board in its semi-annual session. Field Board is comprised of station managers, department heads and district sales managers. Thus, top officers attend a total of four meetings during the course of a year, each meeting covering six full business days.

Value of the meetings, which were originated and are generally conducted by the chairman of the board, Capt. E. V. Rickenbacker, lies in the strong line of internal communications they create. Each member of the organization above the level of assistant supervisor is made acutely aware of the close coordination required of all departments to maintain an efficient and successful operation.

For example, the company's current drive to raise its standard of customer service—Eastern has dropped the word "passenger" in favor of "customer"—was closely interwoven into maintenance, operations and accounting as well as sales activities.

Throughout the meeting, each board member reported on his department's activities during the past six months with recommendations for methods of improving customer service. Problems which threatened to stand in the way of the basic service program were thrashed out with each department involved in the issue at hand.

Pilots were called upon to "keep customers fully informed" during the course of a flight whenever arrival or departure delays were encountered, and maintenance ground crews were instructed to place greater stress upon the cleanliness of aircraft interiors. Costs were emphasized in a discussion on the addition of more personnel to meet improved service requirements.

The airline has added a third flight attendant to its coach flights at a cost of $1.5 million. In this connection, Frank Bennett, assistant vice president-cost control, told the group that wage costs per passenger during the first quarter of 1959 were up 7% over the same period of last year. He called for greater productivity per employe as a means of combating this increased cost.

Latest financial results of Eastern's unique arrangement with Allison and Aeroproducts were brought out in the meeting. Under the plan, Allison will reimburse Eastern for any overhaul costs which run higher than $9.80 per hour of operation of the 501-D13 turboprop and for any engine maintenance costs above $5 an hour.

Guaranteed Level

Similarly, Aeroproducts will reimburse the carrier for any overhaul and maintenance costs on propellers which run over $1.60 and 50 cents an hour respectively. If maintenance costs fall below the guaranteed level of either the engine or propeller, Eastern will reimburse the manufacturers with the difference between actual costs and the guaranteed maximum.

During the first quarter of the year, propeller maintenance costs totaled $1.52 per hour, or $1.02 per hour over the 50 cents maximum guaranteed by Aeroproducts. For the entire period of Lockheed Electra operation, the difference between the actual maintenance cost and guaranteed costs has averaged $1 an hour. Since the period covered 43,988 hr. of operation, Eastern has billed Aeroproducts for $43,988.

Engine maintenance costs averaged $5.96 per hour during the first quarter against the guaranteed maximum of $5 per hour so that Allison must reimburse the airline for the difference of 96 cents per hour.

George Roerig, assistant to the senior vice president, warned against over-scheduling of flights by the entire industry. He told the group that unless the airlines agreed to cooperate among themselves by limiting the volume of flights to airport acceptance rates, the Federal Aviation Agency very likely may step in and regulate schedules for the industry.

Roerig said that many airports are now bogged down by such heavy fre-

quencies of flights that delays in landing and takeoff are inevitable. He doubted, however, that the industry would be willing to voluntarily make any cuts in the present scheduling pattern because of the keen competition between airlines.

Robert Lipp, secretary, pointed to the rapid increase of coach traffic in relationship to first-class traffic. He said that Eastern's coach traffic amounted to 52% of all traffic at the present time compared to an industry average of 42%.

Lipp indicated that coach travel will continue to climb as it did last year when it showed a 6% increase over the previous year as compared with a 4% decrease in first-class traffic. He added that during the year, 80% of the traffic on the New York-Miami run was coach while between New York and Atlanta and New York and Houston only 30% of all traffic was coach.

Analysis of mishandled baggage also was presented to the group. The growing volume of mishandled baggage—from 4,900 mishandled pieces in January to 6,200 in March—was cited as a major block to the carrier's service program. A survey of the problem showed that 49% of mishandled baggage reported was caused by errors in tagging or failure to unload the baggage.

Local Carriers Feel Pinch of Subsidy Cuts

Washington—Local service carriers, hard hit by a 60% cut in subsidy payments ordered by the Civil Aeronautics Board because of a lack of sufficient funds (AW May 11, p. 40), hope for congressional passage this week of a special supplemental appropriations bill expected to provide from $12-16 million needed to cover their operations through this fiscal year ending in June.

Many fear, however, that the nearly three-month cutback in payments may have an adverse effect on their financial positions which may not be overcome for some time. A majority of the carriers already have been forced to arrange short-term bank loans at high interest rates in order to meet payroll costs while other recurring bills are not being paid in some instances, according to an industry spokesman.

In addition, the customary discount applied to bills paid on time is being lost, with many suppliers now demanding cash-on-delivery handling. The carriers point out that none of these added expenses, arising directly from the lack of subsidy money, can be recovered.

Meanwhile, CAB says back subsidy payments will be on their way to the airlines within two days after passage of the supplemental appropriation. Board figures show that $2.1 million, or 60% of the amount due, was owed the local service carriers for the month of March when the cut became necessary. Estimates of sums due in April are $3.8 million; May, $3.6, and June, $3.6, for a total of $13.1 million, the CAB said.

Board spokesmen reported that a similar shortage was experienced in mid-May of last year. A supplemental appropriation was considered unnecessary at that time since the Fiscal 1959 budget became effective within a few weeks of the shortage, and subsidy sums owed the carriers for 1958 were merely deducted from the new budget.

CAB Probes Crashes Of Two Capital Planes

Washington—The Civil Aeronautics Board is investigating crashes of two Capital Airlines' transports within 50 min. of one another at points 450 mi. apart, last week, which took a total of 33 lives.

Thirty-one of the 33 were killed when a Vickers Viscount disintegrated in a thunderstorm near Baltimore, Md., on a nonstop New York-Atlanta flight. Capital said the aircraft's weather radar system was inoperative at the time. All aboard were killed.

Another two persons were killed and six others hospitalized approximately 50 min. earlier when a Capital Lockheed Constellation skidded from the runway, plunged down a 200-ft. embankment and burned during a landing attempt at Kanawha Airport, Charleston, W. Va. The aircraft, with six crew members, two other company employes and 36 passengers aboard, apparently skidded while making a turn on the runway which was wet from a light rain.

U.S. Lines Order CL-44 Turboprop

New York—Seaboard & Western Airlines and Flying Tiger Line last week announced the purchase of 15 Canadair CL-44D-4 turboprop cargo aircraft at a cost of $70 million. Loans covering the purchase will be guaranteed up to 80% by the Canadian government.

Seaboard has ordered five of the aircraft with an option on five more. The carrier has made a down payment of 10%, will pay another 10% on delivery with the balance to be paid over a period of five years. Flying Tiger will purchase 10 of the long-range, swing-tail freighters and also has taken an option on an additional five.

Seaboard will place the aircraft in service in the spring of 1961 on its regular mail and cargo route between the U. S. and Western Europe. At the time of the purchase, Seaboard completed the sale of five of its fleet of nine Lockheed 1049H Constellations and related spares for $9.4 million.

The CL-44D-4, which is powered by four Rolls-Royce Tyne-12 turboprop engines, has a cruising speed of 400 mph. and will carry a 65,000 lb. payload on North Atlantic routes. The swing tail section permits the loading and unloading of 32.5 tons of cargo in 19 min. and will accommodate outsize cargo, including heavy trucks, pipes and missiles such as the Boeing Bomarc or the Douglas Nike ground-to-air weapon systems.

The aircraft has an allowable gross weight of 205,000 lb., is 136 ft. long and has a wingspan of 142 ft. It has a usable volume of approximately 7,400 cu. ft. Takeoff and landing characteristics permit operation of the aircraft into any airport served by Seaboard on its international route.

The contracts with Seaboard and Flying Tiger represent the first time a Canadian-built airplane has been sold to a U. S. airline.

Supersonic Transport Has Prestige Factor

London—No attempt has yet been made to examine, from the manufacturer's viewpoint, the economic and prestige aspects of entering the race for development of supersonic transports, according to the Society of British Aircraft Constructors, Ltd.

The society emphasized that these aspects were outside the terms of reference of the Supersonic Transport Aircraft Committee. The report of this technical committee suggests the development of Mach 2 airliners in spite of the strong possibility of Mach 3 competition from abroad.

It was also beyond the scope of this technical committee to examine the impact of the supersonic project upon government policy of support for the industry as a whole, the society added.

In another development, the British government asked aircraft companies to submit detailed opinions on construction of a supersonic transport, including a report on their readiness to contribute to preparatory investigation and type of organization needed to undertake such a project.

Aubrey Jones, Minister of Supply, said the industry also could give its views on types and specifications, including recommended speeds. The Supersonic Transport Aircraft Committee has recommended design work on two supersonic airliners.

Vertol 107 Demonstrates Stability, Speed

By Robert I. Stanfield

Philadelphia—Stability and IFR capability, coupled to 150-mph.-plus speed and inherent safety features, mark the tandem-rotor, twin-turbine, 24-passenger Vertol 107A. The commercial prototype, flown briefly by AVIATION WEEK, was demonstrated publicly for the first time last week.

Prototype is powered by two Lycoming T53 turbines, which together generate 1,700 shp. First flown in April, 1958, the 107 has made almost 260 flights for a total of about 160 flying hours. Production 107As will be powered by two General Electric T58-8s producing 2,100 shp.

Initial cost, less engines, will run between $475,000 and $490,000. Price will decrease as production increases, and would compare with that of the Vertol 44 type (of which about 700 were produced)—$320,000 completely equipped, including engines—should the equivalent amount of 107s be produced, said Don R. Berlin, Vertol president.

General Electric has quoted a price of $62,000 for commercial T58-6 deliveries in 1961. Prices for earlier deliveries of this engine are being negotiated with interested customers. No firm price, or availability date, has been quoted on the commercial version of the T58-8.

Earliest delivery date for the Vertol 107A would be late 1960. Vertol has the capability to produce two rotorcraft per month. The company can take production orders now for delivery in 15 months. Beginning in September, deliveries will be made in 12 months.

The 107A, with fuselage designed for amphibious capability, will be strongly competitive to the twin-turbine, single-rotor Sikorsky S-61. The helicopter was developed as a company-funded project with the exception of the T53 turbines, which were furnished by the Army. Vertol to date has spent some $1.5 million on the development program (AW July 7, 1958, p. 78).

The prototype 107 demonstrated at Philadelphia International Airport was N74060. Aft section of the rotorcraft was tailored to cargo configuration; forward section has airline seating for seven passengers, plus a jump seat. Features evidenced by the AVIATION WEEK pilot, at the controls with Vertol experimental test pilot Phillip Camerano:

• **Speed.** At 400 ft. altitude, eight passengers aboard, straight and level flight, the 107 indicated 125 kt. (144 mph.) at 90% power. Initial climb at 70 kt. was made at rate of 2,000 fpm.

• **Noise and vibration.** During flight in somewhat choppy air, vibration and noise of the 107 were at a minimum. Passenger conversation level was comfortable. Cockpit transmissions, of course, were via microphone.

• **Stability.** During level flight the 107 was flown "hands off" with no tendency to pitch, roll or yaw. Vertol's electromechanical stability augmentation system embraces a rate sensing gyro in each axis. Sense information is transmitted to amplifiers, then to power source (secondary actuator) which imposes control motion on basic controls. Correction is applied to damp the initial motion sensed by gyros; in pitch damping only the correction is lagged to match stability requirements.

During a recent test flight, stated Berlin, the 107 sped from LaGuardia Airport to New York's West Side Heliport in 5 min.; then to Newark Airport in 5 min.; following which it traveled to Philadelphia International in 32 min.

Specifications show the new 107A to be eight feet shorter than the Vertol 44 now in airline operation. They are of equal weight empty. The turbine-powered helicopter, in comparison with the piston-driven 44, has 50% more cabin space, a 50% boost in speed, a 60% increase in passenger seating, and one-half the seat ton-mile cost.

The twin-turbine, tandem-rotor configuration adds to the 107's safety potential as a scheduled passenger carrier. Vertol strongly believes that the rotorcraft's characteristics—in event of engine failure—can lead to new techniques in heliport operation, in which minimum size heliports would utilize the helicopter's true vertical capability.

Particular emphasis was placed on these two areas:

Vertol 107A

Estimated Direct Operating Cost
(25 naut. mi. route)

	2 T58-8 Engines
Crew	$51.49/hr.
Fuel	36.23
Oil	2.64
Hull insurance	19.66
Total flight cost	$110.02/hr.
Aircraft maint.	51.07
Engine maint.	28.00
Depreciation	74.80
	$263.89/hr.
Block speed	127 mph.
Payload	6,640 lb.
Seats	24
Cost ton/mi.	64 cts
Cost seat/mi	8.5 cts

• **Dead man's curve.** Numerous tests were run on the multi-turbine H-21D in height-velocity combinations at which it normally would be difficult to make a successful landing following engine failure. Results indicated that engine failure in critical areas presented no problem. U.S. Navy local section, in a letter to Vertol, stated that its tests showed no height-velocity diagram is necessary for the 107.

• **Vortex ring.** Condition is theoretically critical between 300 fpm. and 1,200 fpm. rate of descent, when velocity of downwash approximates speed of air coming up. Result is buffeting, sharp increase in rate of descent, and indications of decay in control response. Vertol tests indicate that characteristics of tandem-rotors in vertical descent are such that use of partial power would be a safe maneuver.

This was evidenced in test flights during which the H-21D operated in areas where other rotorcraft of similar disk loading have experienced critical vortex ring condition, AVIATION WEEK was told.

Company further emphasized rotorcraft's safety characteristics as shown in film of H-21D (powered by two T58s, with full stability augmentation system) testing single-engine performance and capabilities. Engine was cut on the helicopter, at weights of from 14,000 lb. to 15,200 lb., at varied altitudes up to 300 ft., no wind.

The helicopter, which in each instance made a vertical ascent, was seen to descend vertically slowly and smoothly following power loss. During the first two tests no collective was applied, said Lloyd H. Sloan, manager, sales engineering. From 300 ft. altitude, the H-21D was nosed down about 150 ft., then flown off in climb out on the good engine.

Vertol began the 107 development program in 1957, with one year from go-ahead to first flight. Gross weight of the prototype is 15,000 lb., rotor radius is 24 ft. Army's YHC-1A will gross 15,500 lb., have same rotor radius.

By comparison, the 107A will gross 18,400 lb. and have a rotor radius of 25 ft. Indications are that the YHC-1B (Chinook) will have a gross weight increase of 25% over the "A" model, plus an increase of several feet in rotor radius.

Army has ordered three of the 107A's military counterpart—the YHC-1A—the first of which is scheduled to fly next month. Army rotorcraft will be powered by two T58-6 turbines. Army also has indicated it will order an undisclosed number of YHC-1Bs, with which it says it will replace its inventory of

VERTOL 107 expects certification to operate in Sea State 3. Fuselage, designed for amphibious capability, is sealed during assembly operations. Lateral water stability is provided by sealed tip fairings on landing gear support structures.

"obsolescent piston-engine transport helicopters." Chinook, in a commercial version, could be equipped with either three General Electric T58-8s or two Lycoming T55s. The former combination has the edge due to two-thirds power potential in event of engine failure.

Powerplants are expected to generate about 3,700 shp.

Passenger cabin of the 107 is of 920 cu. ft. of space. External entrance is at the rear, where loading door swings upward against base of the tail. Loading feature was designed to meet requirements of the military.

Access to the rear entrance is via a hydraulically operated ramp. Dimensions at this point are 78 in. in height by 72 in. in width. The helicopter provides 22 seats for troops, plus troop commander, or 15 litters plus attendants. It will carry 3.2 tons of cargo.

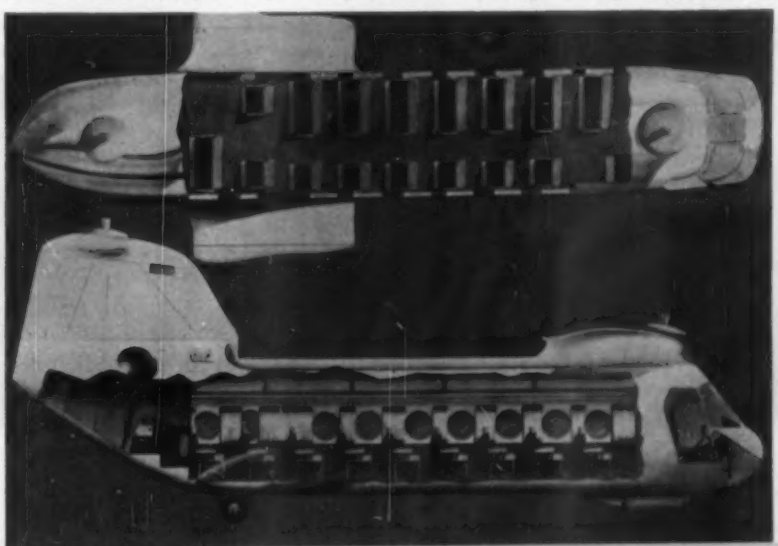
Rear pylon layout of the 107 provides location of side-by-side turbines clear of the cabin area. Control lines and transmission are routed over the top of the fuselage, and housed in a tunnel accessible through hinged panels.

The interchangeable all-metal rotor blades were developed jointly by Army, Air Force and Vertol. Most of the shafting and many rotor components are interchangeable, as are all tires and main gear wheels.

The 107 has but two transmission systems, compared with three on the Vertol 44, plus a mix-box common to multi-engine aircraft. The rotorcraft embraces no pulley brackets; rather, push-pull tubes.

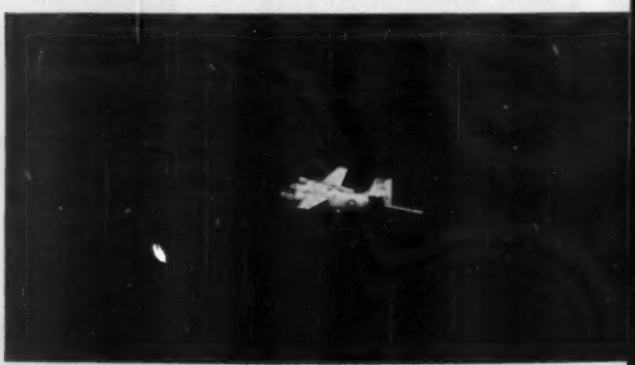
Prototype 107 will be demonstrated at the Paris Air Show in June, following which it will tour major European cities.

PROTOTYPE 107 (above) is powered by two Lycoming T53 turbines. Production 107As will utilize two General Electric T58-8s. Cruising speed is in excess of 150 mph. Commercial 107A, expected by 1960, provides airline seating for 24 passengers (below).

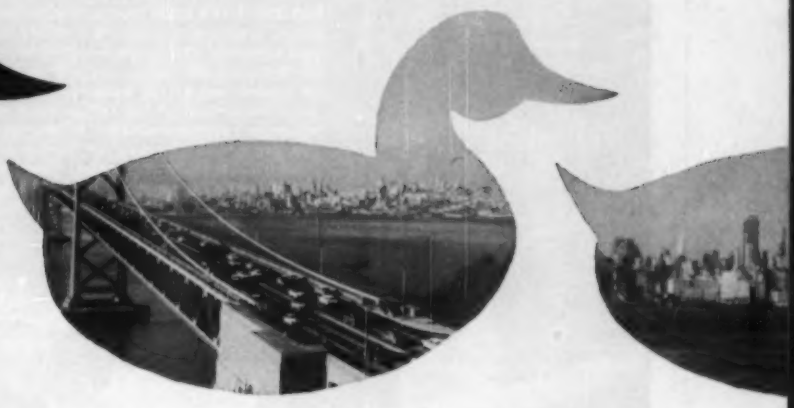


Here are Grumman S2F Trackers on board aircraft carrier, mainstay of United States Navy HUK Group on Anti-Submarine Warfare maneuvers.

S2F starts search with electronic gear that can detect snorkel, periscope, or sub radar, even the submerged sub's disturbance of the earth's magnetic field.



Cities are Sitting Ducks



Coastal cities—of course. Midland cities, too. In fact, any city anywhere in the U. S. is a sitting duck target for missiles launched from subs.

One of the free world's greatest menaces is the submarine.

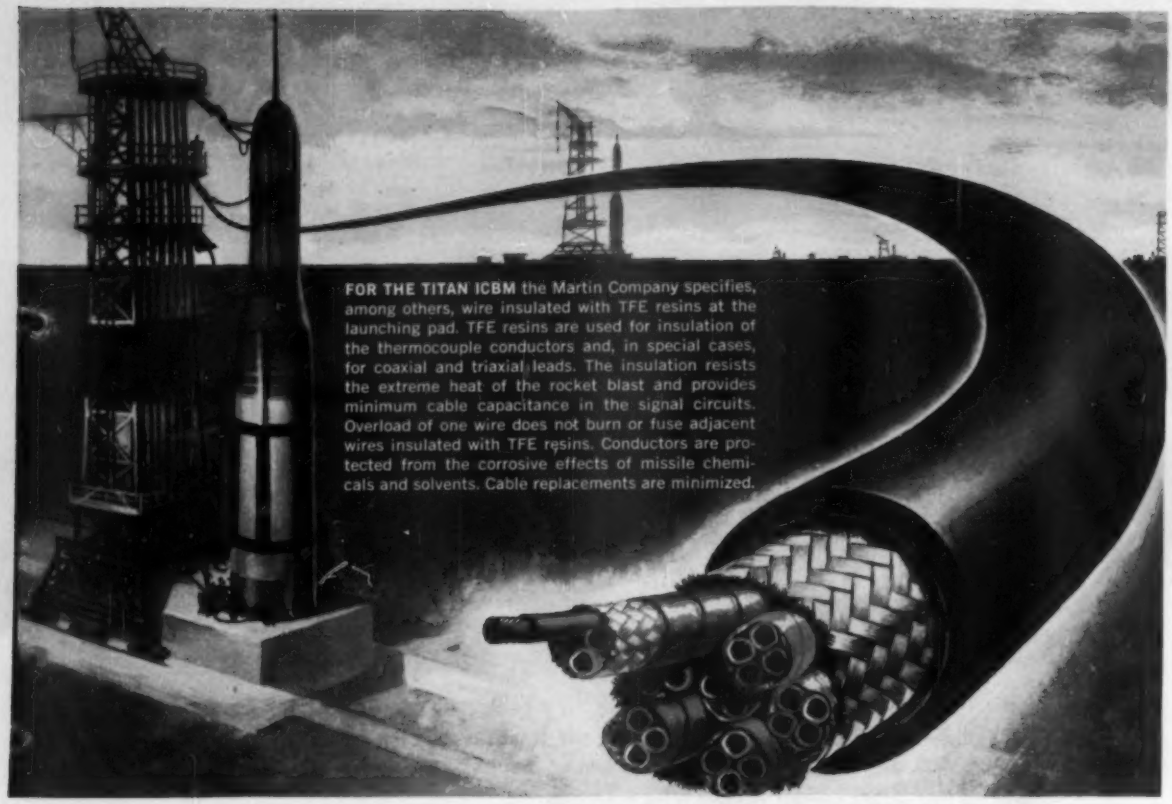
Best protection against this danger is the U. S. Navy—and its long-range anti-submarine task forces. Fixed-wing long-range aircraft, launched from task force carriers, patrol the high seas, probe their depths, screen their contents. They detect, identify and track. And, upon provocation, destroy. They help make the Navy our strongest defense against the threat of the submarine.

These anti-submarine warfare (ASW) aircraft are operational with the Navy throughout the world. Many are Grumman S2F Trackers. They carry the most advanced electronic detection gear plus the weapons that enable them to perform the complete search-attack assignment.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
Bethpage • Long Island New York

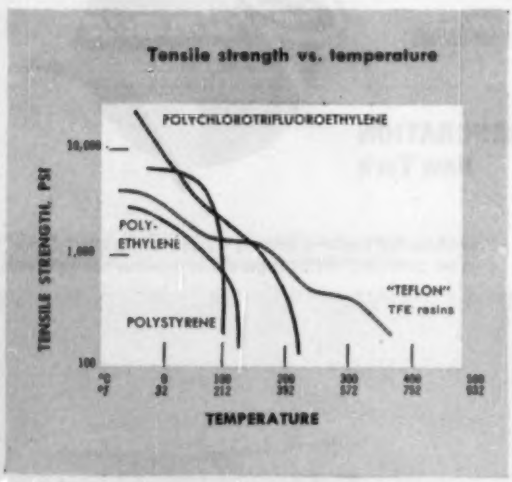
Personnel of Combat Intelligence Center are receiving S2F Tracker report of contact and the dropping of detection devices to pinpoint submarine.

Grumman S2F Tracker is returning to aircraft carrier after "sinking" submarine in war games with depth charges and an ingenious homing torpedo.



FOR THE TITAN ICBM the Martin Company specifies, among others, wire insulated with TFE resins at the launching pad. TFE resins are used for insulation of the thermocouple conductors and, in special cases, for coaxial and triaxial leads. The insulation resists the extreme heat of the rocket blast and provides minimum cable capacitance in the signal circuits. Overload of one wire does not burn or fuse adjacent wires insulated with TFE resins. Conductors are protected from the corrosive effects of missile chemicals and solvents. Cable replacements are minimized.

TFE resins outperform all other organic insulations in resistance to temperatures and heat aging



You can depend on TFE-fluorocarbon resins, because they retain useful mechanical and electrical properties far beyond their continuous service rating of 260°C. In fact, these resins maintain appreciable mechanical strength even past their 327°C. (621°F.) gel point, as the curve at left shows. When you use wire and cable insulated with TFE resins you get an extra factor of safety against high ambient temperatures and conductor overheating due to current overloads. The insulation will not melt, char, burn, embrittle or cut through.

With this type of wire, you can save weight and space, because you can reduce conductor cross-sections and thickness of insulation without sacrificing power ratings. And in production, your electronic assemblies can be soldered rapidly and efficiently without damage to insulation. The outstanding dielectric properties of TFE resins remain virtually unchanged over extremely broad ranges of temperature, frequency and time.

Call your supplier of wire and cable insulated with TFE resins today. He's listed in the Yellow Pages under "Plastics—Du Pont." For additional technical data write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room T-7216, Du Pont Bldg., Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

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TEFLON®
TFE-FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

SHORTLINES

▶ **Aeroflot,** the Soviet state-owned airline, has cut passenger fares 25% on its Northern Territorial Administration routes in a move to stimulate travel. Moscow-Leningrad tariff was trimmed from 200 to 150 rubles.

▶ **Japan Air Lines** has begun once-a-week transpacific cargo flights from San Francisco to Tokyo using Douglas DC-4 aircraft. JAL concluded a three-month charter agreement with Transocean Airlines to operate the transpacific all-cargo flights to carry rapidly increasing amounts of cargo. By the time the charter agreement expires, JAL will be able to spare its own DC-4s for cargo service due to slower traffic on its domestic routes for which DC-4s are currently used.

▶ **KLM Royal Dutch Airlines** has declared a final 1958 dividend of 4% of par value on the company's 100-guilder common shares which is equal to $1.06 per common share. Payment will be made June 15 to stockholders of record of common shares of New York registry as of May 22. At the same time, KLM has ordered 18 ground power units from AiResearch Manufacturing Division of the Garrett Corp., the first of which is scheduled for delivery on June 1 and the remainder by Sept. 1. The units are designed for installation in Volkswagen panel trucks.

▶ **Lake Central Airlines** reports a first quarter net loss of $5,802 due to interest and other non-operating expenses of $10,927. The company's operating profit at the end of the first quarter period was $5,125. Total operating revenues increased by 12.4% while total operating expenses increased only 6%.

▶ **LAV—the Venezuelan Airline,** has increased its Caracas-Rome service from one to two round trips weekly using Lockheed Super Constellations. Eastbound flights on the route leave Caracas for Rome on Sundays and Thursdays, flying via Bermuda, Santa Maria, Lisbon and Madrid. Westbound flights depart Rome on Tuesdays, and Saturdays.

▶ **National Airlines** reports it has flown its one billionth passenger mile during the current fiscal year. The carrier also reports it has carried 57,440 passengers on its New York-Miami run in Boeing 707 turbojet aircraft. The 707s have flown 62,780,000 passenger miles since inauguration of jet transports by National.

AIRLINE OBSERVER

▶ Airline common stocks listed on the New York Stock Exchange have failed to show the strength during the past two weeks that marked activity in the first quarter of the year. Despite optimistic first quarter reports by the 12 trunklines and the spectacular success with turbine equipment presently in operation (AW May 4, p. 52), stocks of 10 carriers last week were down three to seven points from the year's high, although the market generally continued to work higher.

▶ **At least one trunkline is studying the Lockheed Super Hercules turboprop cargo plane for transcontinental all-freight service. Powered with Allison T61 turboprop engines, the plane will have a payload of 50,000 lb. on non-stop transcontinental flights. Loading and unloading facilities permit a turnaround time of 30 min. Delivery of the aircraft is scheduled for 1961.**

▶ Clear air turbulence is becoming a significant problem and will continue to grow as more flights move into high altitudes. Because such turbulence hits aircraft without warning, several proposals have been made suggesting that airline passengers be requested to keep seat belts fastened at all times during the course of a high altitude flight.

▶ **Russian four-turboprop An-10 transports, still being tested in all-cargo service, are expected to boost ton-mileage 35% on Aeroflot's Ukrainian routes this year. The new planes carried 180 metric tons of freight, express and mail from Kiev to Moscow, Leningrad, Sverdlovsk, Rostov and Kharkov during February. They will soon provide service for four other cities—Lvov, Simferopol, Stalino and Odessa.**

▶ National Airlines new low-rate night coach flights (AW April 20, p. 43) operated close to capacity during the first two weeks of operation between New York and Miami. Company President G. T. Baker feels that a large portion of the heavy loads consist of new traffic diverted from the automobile and bus travel markets. National operates 104-seat Lockheed 1049H Constellations on the flights.

▶ **British Overseas Airways Corp. will handle all maintenance of de Havilland Comet 4 turbojets operated by Aerolineas Argentinas in London, Frankfurt, Rome and New York. The Argentine carrier has received three of its six Comets on order and is scheduled to begin regularly-scheduled service between Buenos Aires and London on Wednesday.**

▶ United Air Lines last week signed a contract with the Air Line Pilots Assn. calling for three crew members—all pilot-qualified—for turbojet equipment. The airline has been hiring only pilot-qualified flight engineers since 1954 so that United's crews will now consist of a captain, first officer and pilot-engineer. Under terms of the flight engineer agreement, engineers are given an opportunity to become pilot-qualified. Otherwise, they are given a choice of flying on piston-engine aircraft or accepting severence pay. In other areas, National pilots are taking a strike ballot and TWA and ALPA are holding conferences in Chicago under the National Mediation Board. Northwest and Continental also are in contract negotiations with the union.

▶ **Air Traffic Conference will offer a 50% discount on tickets for domestic air transportation to officers, directors or employes of approved travel agencies. The reduced tariff, which must be approved by the Civil Aeronautics Board, will be limited to two tickets on each carrier per year for each agency.**

▶ Chicago Helicopter Airways expects to average a daily total of 555 passengers during May, compared with a daily average of 319 in March and 444 in April.

▶ **North Atlantic passenger traffic increased 20% during the first quarter of the year as compared with the same period of last year. Cargo traffic climbed 30% during the first three months and mail rose 15%. According to the latest figures released by the International Air Transport Assn., economy class accounted for 65% of all traffic, while only 8% flew tourist class. First class and de luxe traffic made up the balance of 27%.**

Airline Traffic—March, 1959

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	604,251	419,479	66.5	1,875,255	828,651	8,382,533	51,437,997	58.3
Braniff	174,937	76,018	58.7	333,338	178,863	621,755	8,434,231	48.9
Capital	328,975	114,065	58.8	540,515	255,001	335,537	14,940,725	48.1
Continental	71,720	33,830	50.3	88,859	42,839	161,174	3,546,035	44.9
Delta	262,076	139,179	58.6	433,856	278,597	1,262,571	15,378,816	52.8
Eastern	722,972	430,966	56.78	1,060,437	484,634	1,356,353	44,492,467	45.63
National	180,858	125,770	64.2	357,622	80,456	638,273	13,296,337	50.6
Northeast	96,127	52,886	56.3	131,007	37,481	100,379	5,339,818	45.2
Northwest	141,855	109,515	51.8	555,121	239,080	1,397,161	12,708,471	45.5
Trans World	384,675	310,797	63.9	1,304,063	684,102	2,506,438	34,266,159	57.2
United	559,205	390,962	61.2	2,921,109	995,132	6,767,536	48,206,699	56.2
Western	124,098	65,827	60.5	274,077	88,296	322,798	6,997,369	52.4
INTERNATIONAL								
American	11,971	13,249	74.1	10,223	777	263,246	1,639,435	66.7
Braniff	4,117	7,634	50.6	17,475	.....	91,115	945,293	46.3
Caribbean-Atlantic	30,318	2,156	67.7	1,840	.....	5,484	236,338	74.6
Delta	4,096	4,778	48.2	7,305	.....	44,259	581,389	42.9
Eastern	33,712	48,151	55.88	112,561	.....	156,926	5,261,444	39.91
Mackey	14,629	2,951	50.3	.....	231	2,379	321,447	50.2
National	8,280	5,876	59.0	8,092	4,688	33,175	662,273	49.9
Northwest	11,936	27,211	55.0	1,365,829	16,043	917,499	5,192,903	63.1
Pan American								
Alaska	2,747	2,831	40.3	26,056	.....	124,965	458,823	46.5
Atlantic	90,027	115,244	67.6	1,506,627	.....	2,475,639	16,174,926	62.1
Latin America	108,500	112,257	67.8	397,140	.....	4,493,036	16,094,315	68.4
Pacific	26,256	103,986	80.0	1,332,476	.....	2,170,734	14,471,555	73.0
Panagra	11,197	15,915	42.7	72,724	.....	561,904	2,380,685	66.3
Resort	.....	.....	.....	.....	.....	4,472,320	4,472,320	80.38
Trans-Caribbean	5,750	9,175	67.8	.....	.....	136,698	883,570	68.^
Trans World	24,658	75,896	73.4	1,286,018	.....	1,921,562	11,061,758	74.7
UMCA	203	67	48.6	.....	.....	587	7,252	47.7
United	8,086	19,589	65.3	146,247	.....	89,061	2,239,418	65.0
Western	4,251	6,611	63.8	10,103	.....	11,219	720,283	63.5
LOCAL SERVICE								
Allegheny	40,000	6,883	43.9	12,847	19,125	23,506	712,556	44.2
Bonanza	18,499	4,434	55.0	6,152	2,276	7,780	440,873	53.2
Central	13,094	2,601	36.5	7,162	3,583	13,973	274,273	33.7
Frontier	22,403	5,273	39.2	18,122	7,046	49,890	582,486	45.4
Lake Central	16,672	2,646	38.8	3,964	13,001	.....	270,031	41.8
Mohawk	43,187	8,315	54.1	8,649	11,918	14,006	827,426	53.8
North Central	64,275	10,897	44.0	31,643	37,255	.....	1,118,723	45.2
Ozark	44,196	7,530	40.5	13,654	22,016	21,263	776,698	42.4
Pacific*	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont	38,842	7,970	44.7	16,010	11,645	13,842	805,145	45.0
Southern	21,667	3,864	58.1	9,775	10,383	11,011	401,860	38.1
Trans-Texas	22,946	5,323	43.1	17,301	9,021	28,690	565,099	43.8
West Coast	25,707	4,971	45.63	5,977	2,688	9,530	492,916	44.42
HAWAIIAN								
Aloha	15,562	2,172	55.8	1,309	.....	6,729	182,345	54.1
Hawaiian	35,720	5,340	61.2	5,092	.....	116,569	550,003	60.8
CARGO LINES								
AAXICO	.....	.....	.....	6,419	12,476	3,601,863	3,620,758	75.71
Aerovias Sud Americana*	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	1,997	8,455	99.6	41,489	51,511	9,618,338	10,556,763	89.9
Riddle								
Domestic	.....	.....	.....	6,229	21,572	4,197,119	4,224,920	75.7
Overseas	.....	.....	.....	.....	.....	708,819	708,819	68.8
Seaboard & Western	587	2,386	100.0	.....	.....	3,690,882	3,934,761	56.0
Slick	3,063	19,062	97.13	.....	.....	.....	1,906,171	97.13
HELICOPTER LINES								
Chicago Helicopter	9,915	184	35.8	1,361	.....	.....	18,973	30.6
Los Angeles Airways	2,910	107.5	55.7	4,376	2,154	.....	16,309	59.8
New York Airways	7,380	143	38.3	1,884	1,412	631	17,663	41.2
ALASKA AIRLINES								
Alaska Airlines	7,613	3,822	40.4	66,357	2,353	167,813	627,598	48.5
Alaska Coastal	2,994	318	52.0	4,044	.....	2,787	39,376	61.1
Cordova	1,021	250	53.4	3,385	.....	39,127	68,081	44.0
Ellis	3,833	223	57.9	1,689	.....	2,227	26,661	69.2
Northern Consolidated	1,905	557	39.5	30,617	.....	40,020	131,766	58.3
Pacific Northern	7,375	6,607	40.3	110,083	5,392	201,923	1,034,270	51.2
Reeve Aleutian	1,027	842	36.3	33,322	.....	92,531	217,591	59.7
Wien Alaska	3,021	789	16.0	39,866	.....	227,669	348,565	55.8

*** Not available.**
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

Airlines Report Salaries, Bonuses to CAB

Washington—Following is a list of airline officer's salaries, bonuses and indirect compensations, expenses and stocks holdings for the year ending Dec. 31, 1958, as reported to the Civil Aeronautics Board:

International Carriers

Pan American World Airways—J. T. Trippe, president and director, $60,000 salary, $1,950 bonds and indirect compensation, $8,470 expenses and 66,539 shares of common stock in name of others; **W. L. Morrison**, executive vice president—Latin American Division, $36,000 salary, $15,000 bonus and indirect compensation, $6,520 expenses and 17,587 shares of common stock; **H. E. Gray**, executive vice president—Atlantic Division, $36,000 salary, $16,000 bonus and indirect compensation, $3,160 expenses and 7,402 shares of common stock; **R. B. Murray, Jr.**, executive vice president—Pacific and Alaska Division, $32,000 salary, $9,000 bonus and indirect compensation, $16,337 expenses and no stock.

R. Lewis, executive vice president—development and defense projects and director, $36,000 salary, $15,900 bonus and indirect compensation, $6,480 expenses and 2,075 shares of common stock; **J. C. Leslie**, vice-president—administration and director, $35,000 salary, $14,900 bonus and indirect compensation, $5,488 expenses and 9,400 shares of common stock; **S. F. Pryor**, vice president, assistant to the president and director, $32,000 salary, $9,350 bonus and indirect compensation, $41,056 expenses and 15,432 shares of common stock; **H. J. Friendly**, vice president, general counsel and director, $33,000 salary, $15,000 bonus and indirect compensation, $1,895 expenses and 7,500 shares of common stock; **F. Gledhill**, vice president and director, $34,000 salary, $15,000 bonus and indirect compensation, $13,210 expenses and 4,452 shares of common stock.

W. G. Lipscomb, vice president—traffic and sales, $34,000 salary, $15,000 bonus and indirect compensation, $11,499 expenses and 10,908 shares of common stock; **J. B. Gates**, vice president—finance, $30,000 salary, $6,000 bonus and indirect compensation, $5,461 expenses and 100 shares of common stock; **A. P. Adams**, vice president, $30,000 salary, $8,000 bonus and indirect compensation, $13,094 expenses, 1,500 direct common shares and 1,500 common shares in name of others; **E. Balluder**, vice president, $28,000 salary, $7,000 bonus and indirect compensation, $9,650 expenses, 15,825 direct common shares and 5,660 common shares in name of others.

J. C. Pirie, vice president and associate general counsel, $1,772 salary, $4,000 bonus and indirect compensation, $603 expenses and 1,505 shares of common stock; **C. M. Young**, vice president, $17,500 salary, $1,500 bonus and indirect compensation, $8,908 expenses and 4,000 shares of common stock; **R. B. Adams**, vice president, $27,000 salary, $6,000 bonus and indirect compensation; $7,773 expenses and 2,540 shares of common stock; **A. J. Kelly**, vice president, $20,555 salary, $2,500 bonus and indirect compensation, $5,837 expenses and 1,158 shares of common stock; **H. W. Toomey**, vice president, $20,000 salary, no bonus, $7,021 expenses and 427 shares of common stock; **N. P. Blake**, vice president, $14,250 salary, $2,000 bonus and indirect compensation, $2,507 expenses and 1,148 shares of common stock.

H. H. Berke, vice president—service of supply, $25,000 salary, $7,000 bonus and indirect compensation, $7,016 expenses and 2,500 shares of common stock; **E. M. Goulard**, vice president—industrial relations, $20,000 salary, $4,000 bonus and indirect compensation, $6,686 expenses and no stock; **R. S. Mitchell**, vice president—Guided Missiles Range Division, $26,000 salary, $7,000 bonus and indirect compensation, $6,547 expenses and 1,547 shares of common stock; **R. G. Ferguson**, treasurer, $27,000 salary, $7,000 bonus and indirect compensation, $2,752 expenses and 4,699 shares of common stock.

J. S. Woodbridge, comptroller, $27,000 salary, $7,000 bonus and indirect compensation, $3,463 expenses and 1,475 shares of common stock; **H. P. Morris**, secretary and general attorney, $14,000 salary, $2,750 bonus and indirect compensation, $202 expenses, 2,562 direct common shares and 564 common shares in name of others; **S. B. Kauffman**, assistant vice-president—engineering, $20,000 salary, $5,000 bonus and indirect compensation, $3,009 expenses and 9,000 shares of common stock; **W. W. Lynch**, assistant vice president—communications, $24,693 salary, $3,500 bonus and indirect compensation, $10,242 expenses and 2,137 shares of common stock; **J. C. Cone**, assistant vice president, $16,000 salary, $4,000 bonus and indirect compensation, $27,447 expenses and 5,439 shares of common stock.

W. J. McEvoy, assistant vice president, $13,000 salary, $2,000 bonus and indirect compensation, $12,725 expenses and 3,533 shares of common stock; **R. E. Smith**, assistant vice president, $11,111 salary, $1,500 bonus and indirect compensation, $7,878 expenses and 30 shares of common stock; **H. M. Blackwell**, assistant vice president—services of supply, $11,625 salary, $1,500 bonus and indirect compensation, $520 expenses and 52 shares of common stock; **R. P. Monson**, assistant treasurer, $17,000 salary, $5,000 bonus and indirect compensation, $2,685 expenses and 1,334 shares of common stock.

J. E. McGuire, assistant comptroller, $15,000 salary, $2,500 bonus and indirect compensation, $6,148 expenses and 108 shares of common stock; **E. G. Rothrock**, assistant secretary, $12,750 salary, $1,000 bonus and indirect compensation, $4,376 expenses, 28 direct common shares and 53 common shares in name of others; **J. J. Cantwell**, $9,500 salary, $750 bonus and indirect compensation, $1,375 expenses and 94 shares of common stock, **J. Macy, Jr.**, assistant secretary, $13,250 salary, $1,000 bonus and indirect compensation, $213 expenses and no stock.

Following directors did not receive a salary: **H. M. Bixby**, $5,000 bonus and indirect compensation, $1,957 expenses and 5,095 shares of common stock; **N. Chandler**, $300 bonus and indirect compensation, $859 expenses and 1,000 shares of common stock; **R. V. Fleming**, $1,100 bonus and indirect compensation, $488 expenses and 200 shares of common stock; **M. Griswold**, $1,200 bonus and indirect compensation, $286 expenses and 400 shares of common stock; **R. L. Hamill**, $1,500 bonus and indirect compensation, no expenses and 6,000 shares of common stock; **R. W. Howard**, $1,400 bonus and indirect compensation, no expenses and 300 shares of common stock; **D. S. Ingalls**, $1,400 bonus and indirect compensation, $1,708 expenses and 3,044 shares of common stock; **R. Lehman**, $1,300 bonus and indirect compensation, no expenses, 600 direct common shares and 4,400 common shares in name of others; **E. O. McDonnell**, $5,000 bonus and indirect compensation, $1,714 expenses and 1,000 common shares in name of others.

M. T. McKee, $5,000 bonus and indirect compensation, $8,040 expenses and 200 shares of common stock; **J. W. Rockefeller**, $900 bonus and indirect compensation, $4 expenses and 2,500 shares of common stock; **V. F. Taylor**, no bonus, $2,015 expenses, 2,000 direct common shares and 1,500 common shares in name of others.

Following firms and persons were paid for services rendered during 1958: **Paul Aiken**, airmail traffic $15,588; **Athearn, Chandler & Hoffman**, legal, $6,400; **Barnes Breaskin Enterprises**, public relations, $11,588; **Edward Larrabee Barnes Associates**, architects—design and development, $67,538; **Eugene P. Beitler**, advertising $50,570; **W. L. Bond**, consultant, $9,400; **Brumbaugh, Free, Graves & Donohue**, patent, trade-mark and copyright, $5,690; **Burbank & Blagden**, architect $5,500.

Jo Chapman, public relations, $5,510; **Cleary, Gottlieb, Friendly & Hamilton**, legal, $137,245; **Community Chest** contributions, $32,775.

Lee W. Court Associates, advertising, $15,435; **Devon Dennett**, advertising, $6,400; **Dickie-Raymond, Inc.**, sales promotion and advertising, $21,600; **Dick Frederick Agency**, public relations, $8,697; **Flight Safety Foundation**, contributions, $5,000; **Gardiner, Morrison, Rogers & McGuire**, legal, $6,000; **Jack Gourlay**, educational, $7,794; **Graham, Green & Dunn**, legal, $14,307; **David E. Grant**, legal, $5,000; **Grant & Hermann**, legal, $6,829; **John Green Corp.**, public relations, $5,600; **F. E. Guandique**, legal, $10,488; **John W. Hanes**, financial, $5,000; **Harvey Hancock & Associates**, public relations, $10,516.

Haskins & Sells, auditing, $6,581; **Heller, Ehrman, White & McAuliffe**, legal, $5,767; **William W. Holland Associates**, public relations, $12,570; **Clayton Irwin**, public relations, $20,502; **F. D. Kahlenberg**; advertising, $44,807; **Julius Klein**, public relations, $47,462; **George Kohn**, public relations, $5,850; **The Lawrence Organization**, public relations, $10,000; **Lexwood Service**, public relations, $31,274; **The Liberia Co.**, representation, $6,000; **Richard Logan**, public relations, $6,118; **Loomis, Suffern & Fernald**, auditing, $102,510; **Lybrand, Ross Bros. & Montgomery**, auditing, $57,286.

Lowell A. Mayberry, labor relations, $75,903; **J. E. McDonnell Associates**, advertising, $11,568; **Miles & Stockbridge**, legal, $17,918; **National Fund for Medical Education**, contributions, $5,000; **G. Batcheider Ollinger**, consulting engineer, $5,000; **O'Melveny & Myers**, legal, $7,537; **Carlos N. Parraga**, legal, $18,371; **Bruce Payne & Associates**, advertising, $6,671; **Publicite Pan American, S. A.**, public relations, $9,882; **Roberts & Holand**, tax counsel, $7,476; **Roosevelt & Freidin**, labor counsel, $25,284; **Kimball Sanborn**, mail consultant, $20,300; **Sanderson & Porter**, engineering, $27,591; **Selvage & Lee, Inc.**, public relations, $38,375; **Skadden, Arps, Slate & Timbers**, legal, $14,623; **Smathers, Thompson & Dyer**, legal, $12,547; **Steadman & Collier**, legal, $7,287; **Steptoe & Johnson**, legal, $80,666.

Ed Sullivan Radio & Television Production, advertising, $7,500; **Lowell Thomas**, public relations, $5,925; **Dick Tullis**, public relations, $6,600; **Charles S. Wayne Associates**, advertising, $32,827; **Hanneiore Wuesten**, advertising, $6,183; **Arthur Murray, Inc.**, advertising, $13,000.

Domestic Carriers

National Airlines, Inc.—G. T. Baker, president and director, $48,000 salary, $18,273.35 expenses and 182,680 shares of common stock; **J. C. Brawner**, senior vice president and director, $24,000 salary, $2,678.40 expenses and 3,617 shares of common stock; **W. D. Caldwell, Jr.**, assistant treasurer, $12,000 salary, $697.89 expenses and 64 shares of common stock; **L. W. Dymond**, vice president, $20,000 salary, $727.24 expenses and 567 shares of common stock; **R. A. Fitzgerald**, vice president, $15,000 salary, $329.14 expenses and 120 shares of common stock; **R. P. Foreman**, secretary and director, $15,000 salary, $1,133.39 expenses and 4,529 shares of common stock; **R. S. Grant**, assistant vice president, $15,000 salary, no expenses and 56 shares of common stock.

A. G. Hardy, senior vice president, $24,000 salary, $2,197.19 expenses and 2,375 shares of common stock; **W. F. Johnston**, assistant treasurer and assistant secretary, $15,000 salary, $680.19 expenses and 2,754 shares of common stock; **J. L. Morris**, vice president, $15,000 salary, $3,696.43 expenses and 3,493 shares of common stock; **G. W. Paul**, assistant vice president, $12,000 salary, $30.76 expenses and three shares of common stock; **W. A. Perry**, assistant vice president, $12,625 salary, $1,016.72 expenses and 223 shares of common stock; **H. K.**

Bloodhounds ready for launching during acceptance trials at Woomera

EFFECTIVE

More advanced Bloodhound for defence of UK confirms particular suitability for European defence needs

Already in operational service with the RAF and adopted by non-NATO Sweden, Bloodhound Guided Weapon System is now to be further developed for the RAF.

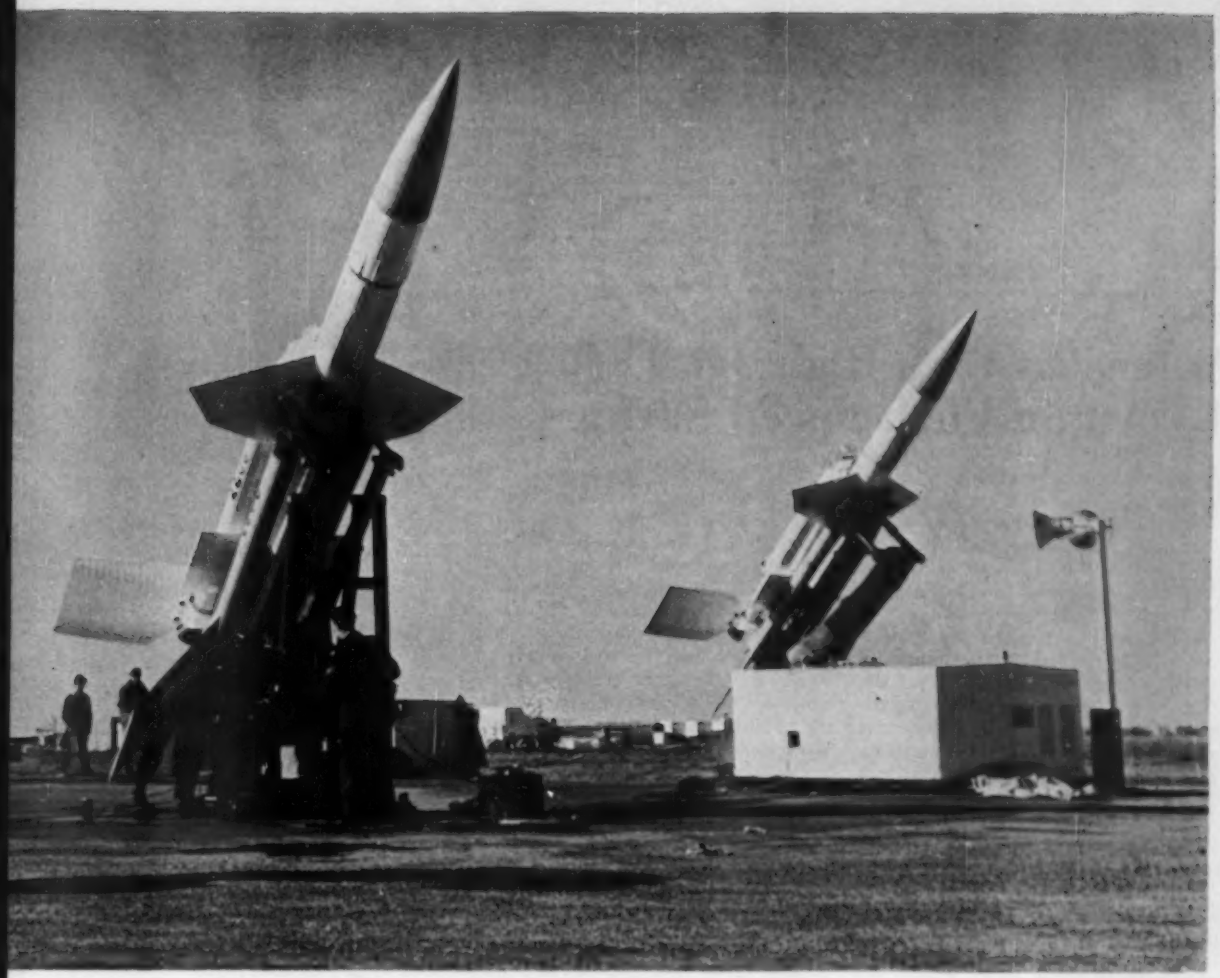
This developed Bloodhound possesses substantially increased operating range and altitude, with advanced technique ensuring still greater lethality at these increased ranges and heights. Low altitude performance is further improved to counteract the threat of low-flying targets.

By developing Bloodhound to meet a threat, the RAF is making use of an existing system which obviously has economic and operational advantages.

Proved in many hundreds of test firings; built by Europe's largest missile-manufacturing complex; and particularly suited to European defence needs, Bristol/Ferranti Bloodhound forms *the world's most effective defence system now and for many years to come.*

Security forbids publication of full details, but the following facts about Bloodhound can now be given:—

WEAPON DESIGN AND CONSTRUCTION BY BRISTOL · GUIDANCE AND CONTROL BY FERRANTI



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DEFENCE

Power. The Bloodhound is powered by two Bristol Siddeley ramjets—jet engines with no moving parts. Ramjets ensure power and range flexibility, burn kerosene, are simple and safe to handle.

Homing System. Semi-active: i.e., ground crew directs radar beam on to target, which is reflected to a receiver in Bloodhound, ensures highest accuracy—regardless of range. Missiles may be fired, singly or in salvoes, using only one radar.

Airframe. Employs unique and advanced monoplane moving wing configuration—two advantages: quicker and more precise response, as well as greater accuracy of interception; superior at high altitudes. This configuration was selected at initial design stage to embody maximum development potential.

BRISTOL/FERRANTI

Bloodhound

GUIDED WEAPON SYSTEM

BRISTOL AEROPLANE CO (USA) INC
400 PARK AVENUE, NEW YORK 22, NY

TARGET ILLUMINATING RADAR BY BTH · SYSTEM SALES ORGANISATION BY BRISTOL AIRCRAFT LIMITED

Pike, vice president (left office 2/21/58), $2,187.50 salary, no expenses or stock; **J. M. Rosenthal**, senior vice president, $24,000 salary, $2,028.90 expenses and 3,956 shares of common stock.

C. F. Sharp, assistant vice president, $14,375 salary, $1,510.84 expenses and 1,128 shares of common stock; **W. Sternberg**, senior vice president, $24,000 salary, $4,563.60 expenses and 150 shares of common stock; **R. E. Wieland**, vice president, $15,000 salary, $1,621.98 expenses and 3,856 shares of common stock.

Following directors were not paid salaries or expenses: **J. W. Cross**, 3,166 shares of common stock; **G. W. Gibbs, Jr.**, 69 shares of common stock; **B. O. Hedges**, no stock, **E. C. McDonald**, 775 shares of common stock; **P. R. Scott**, 2,263 shares of common stock; **D. R. Topping**, 2,262 shares of common stock; **J. A. Waterman**, 585 shares of common stock; **B. Winters**, no stock; **A. G. McNeese, Jr.**, 103 shares of common stock.

Following firms and persons were paid for services rendered during 1958: **Denning & Wohlstetter**, legal, $6,179; **John W. Cross**, legal, $42,591; **Scott, McCarthy, Preston, Steel & Gilleland**, legal, $38,676; **Wechsl, Schulman and Manning**, legal, $13,523; **Claude Pepper**, legal, $15,000; **Investigators, Inc.**, management research, $47,450; **Alexander and Alexander** actuarial, $14,269; **Stryker, Tams Horner**, legal $5,824; **Getch & Crawford**, statistical, $9,700; **Haskins & Sells**, auditing, $12,650; **Communications Counselors, Inc.**, public relations, $62,500.

American Uses High Jet Thrust To Attain Fuel, Speed Savings

By Glenn Garrison

New York—American Airlines has found that maximum cruise thrust is better economically as well as from a speed standpoint for its Boeing 707-120 transcontinental jet operations.

In the period before the jets actually went into airline service, American as well as other carriers, had stressed the need for economic rather than speed-racing operation to get the best results from its new aircraft. However, recent studies have convinced American that fuel consumption curves worked out a little better with the higher speed cruise over the cross-country route.

The airline, along with Boeing Airplane Co., ran over 2 million simulated transcontinental jet flights and found some unexpected dividends in planning for maximum cruise thrust. Curves for that speed configuration, from an economic standpoint, always ran equal to or a little better—never more than 1%—than the curves for long range cruise.

These conclusions apply to the Pratt & Whitney J57 engine and not necessarily to the more powerful J75 that will be installed in later aircraft. The J57, according to American, is somewhat underpowered. It was necessary to fly at maximum cruise thrust for the first half of a transcontinental trip in order to get the best cruise altitude. Finishing the flight at the higher speed worked out better economically than cutting back to long range cruise at that point, American said.

Sales View

This is a happy conclusion from a sales view since it justifies shortest coast-to-coast scheduled times.

American has learned a number of other lessons from its actual experience since Jan. 25 with scheduled jet operations (AW May 4, p. 38). The airline has discovered, for one thing, that it's the little things that count in operating problems.

Take the matter of a pointer on the knob of the manual override to the automatic cabin temperature controls. A pointer had not been installed, American discovered after the automatic controls failed and the flight engineer ran back to use the override. Because of the absence of a pointer, he didn't know which way he was turning the knob, and the shaft broke in the full up position. Result: a most uncomfortable flight for a planeload of scheduled passengers.

Another small item was the use by Boeing of a ⅜ in. diameter plug throughout the fuel gage wiring system. The plug was selected for compactness. However, its design involved a tedious soldering problem, and wiring failures in this system have been the greatest statistical cause of scheduled delays. American has been going through these systems of its 707-120s and resoldering every plug. Next move will be to get a replacement for the plug.

Baggage System

Another problem was with the mechanical hoist of the new baggage handling system in American's Boeings and Lockheed Electra turboprops. This was straightened out in a couple of weeks, however, and American feels that the system is worth all the time and effort that went into it. With the system, which involves preloaded containers, American now gets the first half of a baggage load into the terminal before the first passenger arrives.

Among the adjustment problems with the 707-120 has been convincing the pilots that the thrust reversers really work, according to American. With the heavy airframe of the jet, pilots can't feel the deceleration as in piston planes. Some pilots landing the airplanes and using the reversers have sworn they didn't work, but only made a lot of noise. The pilots were instructed to make brakes-off landings to prove the point, which succeeded.

Taking off from a slushy runway, American has found, creates a planing drag greater than the rolling friction, a problem which probably always existed but never noticeably until the jet operations began. Runway length, of course, has not been as critical before. American believes this slushy runway limitation must be met by new and better runway drainage and snow removal procedures.

In handling jet passengers on the ground at Idlewild, American has had the advantage of departure lounges the airline constructed for that purpose. In the lounges, passengers for a flight are separated and the flight loaded as though it were two airplanes, one being the front entrance group and the other the rear entrance group. The largest passenger-handling headache has been standbys, who can fall into six categories as to what accommodations they prefer and will or will not accept. Without the lounges, American believes, jet passenger handling at Idlewild would have been a major problem.

'Greatest Show'

At San Francisco, departure lounges were built without windows and the concourse was closed off for 75 ft. Passengers can't see the jet activity outside, and American next time won't "hide the greatest show on earth from our paying customers." Also, passengers looking for a view anyway have wandered down the concourse and caused delays, often when they encountered an airport bar.

In taxiing the 707-120 to a passenger gate, American has found it desirable to add about six feet of straight roll before stopping and after the 90 deg. turn has been accomplished. Otherwise tensions in landing gear assembly can cause seals in the strut to leak.

American, first transcontinental jet operator, has learned some lessons from its experience which should ultimately benefit not only American but its successors on the jet route. The airline believes that more experience will refine jet handling techniques to the point that some present procedures, such as towing away from the gate at Idlewild, can be avoided.

Jet Passenger Aide

Denver—Continental Airlines plans to add a director-passenger services to the crew of its Boeing 707-120 jet transports, scheduled to go into Chicago-Los Angeles service on June 8.

The new crewman will collect tickets, fares from passengers without tickets, and excess baggage charges. He also will handle connecting reservations and ground arrangements by special radiotelephone from the plane.

Business

The 8th definition of **business**, according to Webster, reads as extracted, "... to increase business by advertising." This advertisement has the sole purpose of offering the capabilities of BJ Electronics, Borg-Warner Corporation, to military suppliers for the manufacture of precision electronics. From your print specifications, this establishment will fulfill orders quickly and economically, utilizing 10 years of know-how and over 90,000 sq. ft. of new, completely equipped facilities. Consider your need, then ... consider this a direct solicitation of your sub-contract electronic business.

Write for facilities brochure. BJ Electronics, Borg-Warner Corporation, 3300 Newport Boulevard, Santa Ana, California.
National Direct Dial Number 714 KI 5-5581, TWX 5291.

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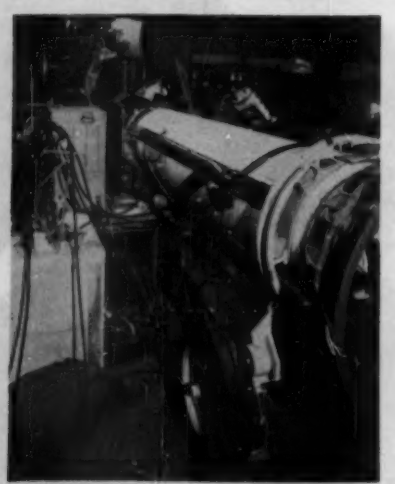
TECHNICIANS conduct "covers-off" tests of integrated subsystem operations, primarily a sequencing check, on Aerojet-General's second stage of Thor-Able vehicle used by Ballistic Missile Division as advanced re-entry test vehicle.

Space Technology Laboratories—Part 1:

STL Broadens Missile, Space Roles



FLEXIBLE lines on Thor-Able second stage lead pressure into subsystems during a sequence check of valves, regulators.

(Space Technology Laboratories, Inc., occupies a unique and sometimes controversial position in the nation's defense effort. Aviation Week's Los Angeles bureau manager, Irving Stone, has interviewed the top officials of STL and has made a study of the company's history, its relationships to government and the rest of industry, and its growth and achievements in its short but unusual lifetime. This is the first of three articles.)

By Irving Stone

Inglewood, Calif.—Space Technology Laboratories, Inc., has evolved within a short time into a technical right arm for the Air Force's ballistic missile program and has assumed an important role in the nation's space efforts. Extent and impact of STL's work is not generally recognized by segments of industry other than contractors who have been closely associated with STL in specific missile and space projects.

STL exists in close relationship with its supervisory agency, the Air Research and Development Command's Ballistic Missile Division. Working through BMD, STL also performs top technical assignments for the National Aeronautics and Space Administration.

With almost 1,000 technical staff members spanning a broad range of scientific talents, STL provides a unique technical input to missile and space programs, from detailed analytical engineering and staff assistance to "far out" studies and experiments.

To occupy this position, STL has had to strive for technical objectivity on a large number of subjects. To help in this attempt to maintain objectivity, the company has excluded itself from production work. STL's management contends that it has deliberately taken a course that is not necessarily the most profitable, nor one that will enable it to grow into a very large company.

Its relationship to USAF's ballistic

JAMES H. DOOLITTLE

STL Chairman Doolittle

James H. Doolittle (Lt. Gen., USAF, ret.), who recently became chairman of the board of Space Technology Laboratories, deals principally with the organization's policy and planning for the future. He works closely with STL President Dr. Louis G. Dunn and Dr. Ruben F. Mettler, executive vice president.

The only other commercial affiliation that Doolittle retains is as a director of Shell Oil Co. He has given up a large number of other activities to devote almost full time to STL. He still serves on the President's Advisory Panel on Foreign Intelligence and on the Air Museum Advisory Committee of Smithsonian Institution. He is a life member of the Corporation of Massachusetts Institute of Technology, is chairman of its Visiting Committee on Sponsored Research, and is a member of the Engineering Advisory Committee of the University of California. Doolittle was chairman of the National Advisory Committee for Aeronautics until it became the National Aeronautics and Space Administration last Oct. 1. He has been associated with the Air Force's missile program since its inception.

Looking at the long haul ahead he emphasizes that our educational system must be improved to produce more high-grade scientists and engineers, that programs of basic research must be sustained to give us a stockpile of fundamental knowledge, and that there must be consistent research and development programs to provide both civilian and military tools—missiles and satellites.

He believes that the Soviet Union's recent rate of technical advance was possible because more than three decades ago it began to put great emphasis on education and science and developed incentives to stimulate intellectual excellence. Doolittle says:

"I don't ordinarily advocate emulating Russia, but I feel that we, too, must give increased support to educators and increased kudos to mental capabilities. Young men of high intellectual attainments should get the same recognition and reward as one with high physical attainments—either a collegiate or professional athlete."

missile program also means that it cannot afford to be "buddies" with industry members because it is sometimes called upon by USAF to make recommendations that affect the choice of a potential contractor, according to Dr. Ruben F. Mettler, executive vice president and acting director of the Systems Engineering Division.

Mettler maintains that the headway made in the ballistic missile program and STL's contributions toward the meeting of time schedules reflects the correctness of decisions that it has been able to make without the pressures of non-technical problems. He does not minimize STL's hope of becoming a healthy financial organization, but he emphasizes that the primary goal is to become the best technical group in the industry.

Main Work Areas

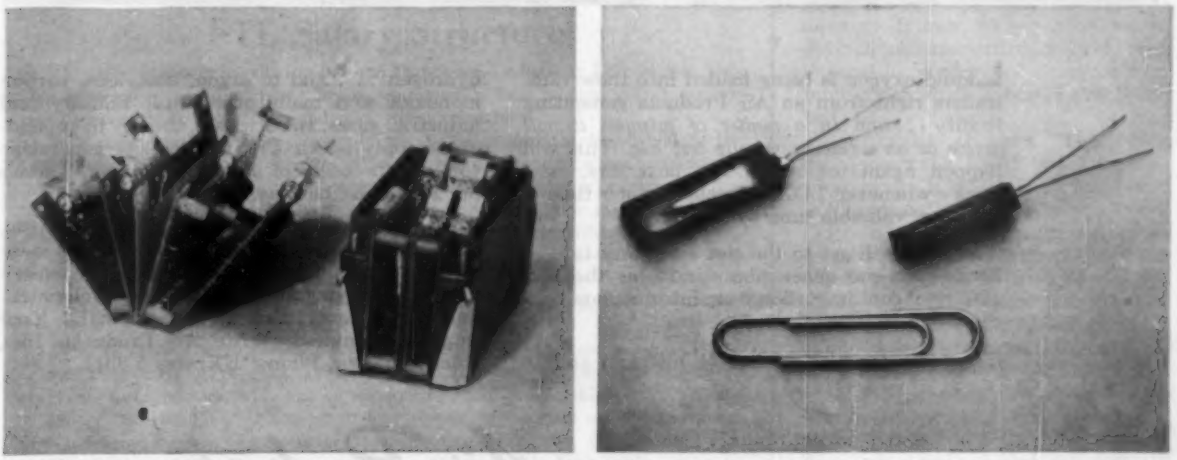
STL's effort is channeled into four main categories:

• **Systems engineering** and technical direction for USAF's ballistic missile program, including the Atlas, Titan and Minuteman intercontinental missiles and Thor intermediate range missile.

• **Laboratory experiments.** This work, carried out in STL's electronics, astrovehicles and physical research activities, has two objectives. First is to advance the state of the art. Wide scope of projects range from such important future areas as thermonucleonics and magnetohydrodynamics to new ways of packaging electronics. Second objective is to support systems engineering. This has application to today's projects, as distinguished from those which may have application five years from now.

• **Space flight projects.** Formerly conducted for both National Aeronautics and Space Administration and Advanced Research Projects Agency, this work is performed for both NASA and ARPA under USAF contracts. Projects include lunar and space probes and are characterized by very high scientific content. Work has an exploratory aim and involves no production orders. STL designs hardware, checks it out, tests it and eventually is associated with the flight in which it is used.

In these first three categories, STL has a line responsibility to the Air Force, NASA, or ARPA as the case may be, in the sense that the government places



ELECTRONICS MODULE, developed by Space Technology Laboratories' Electronic Laboratory for a study of packaging techniques, includes Atlas ICBM components (left). Study showed weight of certain guidance parts could be cut 60%. At right is a lightweight, inexpensive transducer which weighs only .03 ounces, also developed by STL.

The logistics of LOX

Liquid oxygen is being loaded into these tank trailers right from an Air Products generating facility . . . *and in a matter of minutes it will arrive at an adjacent missile test site.* This will happen again tomorrow, the next day, next week—whenever LOX is needed. Each time it happens, valuable time will be saved.

The LOX will get to the test site purer too . . . because on-site generation eliminates the possibility of contamination from intermediate handling and storage.

The same logistics applies to nitrogen and to hydrogen . . . and to argon, acetylene, carbon monoxide and many other vital military and industrial gases. In each case, the key to dependable supply is Air Products on-site generation to serve the needs of a single customer. There's no "overland" hauling, no waiting in line.

Air Products skilled team of engineers, chemists, physicists and designers . . . our specialized manufacturing facilities . . . and our valuable experience in supplying all major missile development and test centers . . . are at your command. Your inquiry is invited. Write Air Products, Inc., Allentown, Pa. Phone: EXpress 5-3311.

Air Products
...INCORPORATED

STL and the contractors engaged in the weapon system project in a line-grouping for all technical operations. If this arrangement were shown by a chart, STL would be just beneath the Air Force. Below STL, the vertical line would branch out into a horizontal line, beneath which the various contractors would be included.

• **Technical staff assistance** to Air Force. Here, STL literally is staffed to the Air Force. On specific request from Ballistic Missile Division, STL performs studies and analyses on general subjects in the field of ballistic missiles and space technology. Study which led to Minuteman, a second-generation missile (AW Jan. 19, p. 68), is a prime example of STL's staff function to BMD, although the study was not limited to STL.

Minuteman Concept

Early in 1957, Air Force requested a study of the characteristics of second-generation missiles. STL's recommendation evolved into the Minuteman concept. Later, Air Force also asked STL to assume line responsibility for the Minuteman project.

In its staff function in connection with Minuteman, STL considered both liquid and solid propellants, two-stage and three-stage configurations, a wide range of warhead weights, various ranges of up to 10,000 mi., a number of accuracies, all-inertial versus radio-inertial guidance systems and operational concepts which included mobile, hardened and dispersed environments. Louis G. Dunn, STL president, personally directed these studies.

Out of these analyses came a series of alternatives, but the best choice seemed to lie in a highly simplified, relatively inexpensive three-stage missile weighing about 65,000 lb., using a solid propellant, and deployed in a dispersed and hardened environment. Mobile aspects for the system also were envisioned. STL's study on Minuteman under its staff relationship to USAF ended in 1957 and three or four design configurations were presented for consideration. Final choice was made by a group consisting of ARDC, Air Materiel Command, Strategic Air Command and Department of Defense.

This staff assistance leading to the Minuteman concept is very similar functionally to the work of North American Aviation, Inc. and Boeing Airplane Co., which led to the B-70 Mach 3 bomber. There is one important exception. Throughout the staff assistance function, both STL and the Air Force knew that the principal fruits of this technical work, namely large-value production contracts, would go to contractors other than STL.

Mettler relates STL's contributions to a very critical aspect of the position of the U.S. versus that of Soviet Russia. In the broad race with the Soviets, Mettler feels that nothing is more important than "buying time." He cites the beginning of the big missile program. Before 1954, Convair had stubbornly supported development of the Atlas almost on its own. When Atlas was redirected and accelerated in 1954, main impetus in Washington stemmed from intelligence which indicated that Russia had had a ballistic missile program for a number of years. Thus, from the moment that USAF began its major effort in the ICBM field, it had begun to "buy time."

Its ballistic missile role was established with the setting up of the Western Development Division of Air Research and Development Command, later renamed Ballistic Missile Division, to implement the program. Later, in the fall of 1954, Ramo-Wooldridge—out of which STL evolved—was given responsibility for systems engineering and technical direction of the Atlas program. Previously it had provided technical staff assistance to the Air Force.

Mettler believes that the "buying time" approach paid off. He says

DATA REDUCTION CENTER at Space Technology Laboratories analyzes miles of magnetic tape containing data compiled from telemetry systems of ballistic missiles in flight. Air Force Pioneer lunar probe space data was processed in the center.

STL Salary Structure

The criticism has been raised in industry that Space Technology Laboratories, Inc., has attracted its technical talent by paying unusually high salaries. STL's management denies this emphatically, and offers this explanation:

As a result of the peculiar responsibilities STL has assumed in relation to the Air Force's ballistic missile program, it is obliged to have a high concentration of senior personnel—relatively higher than is found in other industry organizations. These employes, STL says, have a scarce combination of capabilities as both scientists and technical managers. As a result of this high concentration of senior personnel, it appears that average salaries are high, STL management points out.

More than two-thirds of the scientists and engineers who have left STL in the past year have separated because of better financial offers elsewhere, but this turnover has been less than 10% of the total force.

With the exception of corporate officers, STL officials say, there is no STL employe who makes more than $30,000 yearly. However, because of competitive pressures from industry, STL may be required to revise this situation.

One STL official said: "You never hear anyone saying that any specific industry company pays its engineers or scientists too much, but because of STL's unique relation to the Air Force, this type of squawk has been made. Actually, Air Force scrutinizes STL's salaries in detail in the same way it looks at salaries in other companies operating on cost-reimbursement contracts, as STL does."

Expressly developed to make life easier for missile makers . . .

NEW USS AIRSTEEL X-200

Air hardens to 270,000 psi tensile strength. Can be formed in "soft" condition . . . welded by conventional techniques.

Until now, things have been pretty rugged for missile makers. The high alloy steels they have had to use to get the ultimate strength and heat resistance needed for missile skins and structures have given them plenty of problems.

Such steels are normally hard to form and cut. Welding is a tricky and complicated job. But what really fouls up production is the fact that high alloy steels, to attain high strength levels, generally must be quenched in oil or salt. This calls for huge, costly-to-build quenching tanks.

That is why the development of USS AIRSTEEL X-200 is welcome news to missile and rocket makers. For here is a missile steel that develops its ultra-high strengths *without* cumbersome, time-consuming quenching procedures and so avoids the hazards of non-uniform strength, distortion and improper sizing that can plague the fabricator of large missile parts.

AIRSTEEL X-200 is the result of careful balancing of carbon, silicon, chromium, molybdenum and vanadium to create a steel that can be welded, is air hardenable and finally tempers at relatively high temperatures to provide consistent high strength. *Thus, a missile part can be shaped and welded in its soft condition, then heated, and cooled in air and tempered to develop its strength.* In this stage, Airsteel has a minimum yield strength of 230,000 psi and a tensile strength of 270,000 psi in sheet and light plate thicknesses.

Here is a missile material that has been spun, cold formed, deep drawn, rolled to form cylinders, and welded in exhaustive fabrication tests. Several major manufacturers are applying USS AIRSTEEL X-200 today as motor case material for solid fuel missiles. We invite your consideration of this new material, its high strength-to-weight potentialities, its overall ease of fabrication, to help solve your problems in missile manufacture.

USS AIRSTEEL X-200 is currently available in the form of plates, sheets and strip, as well as in bars, welding wire, billets and blooms for further processing.

Comprehensive technical information is available through your nearest USS representative by simply sending us the completed coupon below.

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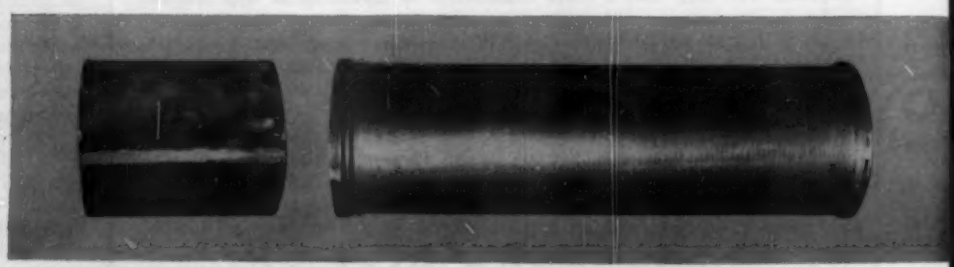

Proof of weldability and workability. *The small cylinder* was shaped and welded from annealed ¼-inch AIRSTEEL X-200 plate and spun into a long cylinder with 0.080-inch walls. The weld showed no cracking.

United States Steel, Room 2801, 525 William Penn Place, Pittsburgh 30, Pa.
Please send complete information on USS Airsteel X-200.

Name..... Position..... Company.....

Address..... City..... Zone..... State.....

bluntly: "We still stand on the record," and points out that in 1954 the von Neumann committee estimated that ICBMs might be operational in the period 1961-1962. Operational date for an initial number of Atlases now is expected to fall in mid-1959.

Mettler points to the Douglas Thor program as another example. First directive to USAF to initiate the Thor program came in November of 1955. Within the next 30 days, guidance, nose cone, propulsion and airframe contractors were brought into the program. STL provided the specifications for this job. Within a period of approximately three years, the research and development program had been completed, the ground support equipment and training phase had been implemented and the missiles deployed. SAC crew fired the Thor with operational ground support equipment at Vandenberg AFB within the three-year period.

Referring to all ballistic missile progress, Mettler gives full credit to the unusual skill of the Ballistic Missile Division and its procurement counterpart, Air Materiel Command's Ballistic Missile Center, and the contractors they have assembled. "Best design is worthless if you don't have a team such as this, complemented by an exceptionally qualified group of contractors," he said.

Systems Engineering

A breakdown of systems engineering and technical direction into its many ramifications emphasizes the great amount of detail involved in this approach to a ballistic missile program.

A weapon system is an aggregation of subsystems which are functionally and sometimes physically interdependent. One subsystem may be affected by another, perhaps by many or even all the other subsystems.

Typical subsystems in a ballistic missile include airframe and associated tankage, engine, propellant utilization, pressurization and propellant supply, guidance, controls and servos, nose cone and warhead, auxiliary power supplies and power distribution, various hydraulic and pneumatic subsystems.

Even the missile itself can not be looked upon as the system because it is only one part of the over-all weapon system, which includes a transporter-erector, crew, communications, installations, logistics backup, maintenance and checkout gear, launcher, targeting procedure, etc.

Primary aim of STL's systems engineering and technical direction assignment is the interrelating of all elements of the ballistic missile system. Broadly, here's how it goes about the job:

• **Basic step in systems** engineering is an assessment of the state of the art in the relevant regimes such as hypersonics, inertial guidance, nuclear develop-

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MULTI-CONDUCTOR CABLES for MISSILES and ELECTRONIC APPLICATIONS

Combining the light weight, superior dielectric properties, heat resistance and solvent resistance of teflon*insulated conductors with the tough abrasion, temperature and solvent resistance of a woven nylon jacket, nylon finished, a cable has been made available that is particularly suited for use in missiles and electronic applications.

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Available in various conductor sizes as required or in combinations of sizes consistent with standard manufacture.

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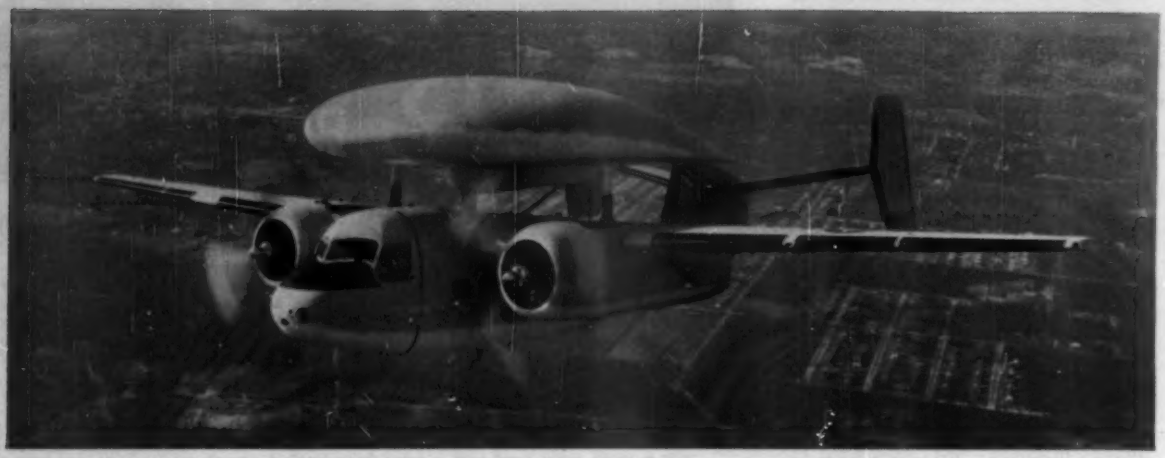

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ment and propulsion in conjunction with explicit war-gaming. This is done to establish a new but reasonable weapon requirement, designated by USAF as a general operational requirement (GOR). For a ballistic weapon, this specifies values for warhead weight, range, accuracy, over-all size, mobility, environment hardness and other relevant characteristics.

This probing of state of the art versus war-gaming becomes a back and forth procedure in which a deeper look into scientific possibilities permits more detailed war-gaming. This in turn prompts keener questions relating to state of the art, according to Dr. William M. Duke, STL vice-president and director of its Research and Development Division.

• **Once a GOR has been** issued, next step in systems engineering is to make detailed parametric studies. Parameters might include propulsion specific impulse, mass ratio, thrust-to-weight ratio, guidance weight per mile of circular error of probability (CEP), drag coefficient versus control means and so on. Varying this group of parameters in a process of engineering synthesis leads to a number of competing functional configurations which will be capable, in varying degrees, of satisfying the GOR.

• **Mathematical or analytical** models of the various configurations are created next. Examples are models for subsystems (an engine), key physical determinatives (a re-entry model) and the all-up model (such as the trajectory ensemble). Other models might relate to control, guidance, heat transfer and dynamics of the all-up system. These models evolve from interaction diagrams, from differential equations describing relevant physical processes and from functional relationships between various parameters or components of the missile and their interaction with local environment. For ease of adaptation to computers, these models are expressed as a series of finite difference equations.

• **Models are analyzed** to eliminate marginal configurations. Analysis covers a series of computer runs with all variables widely ranged. In this area, STL prefers to apply large elements of judgment with respect to ranges of the variables, linearization of complicated functional relationships and elimination of higher orders—not so much for computation efficiency as for a proper engineering understanding of results of computer runs. Shakeout of this model analysis gives a number of critical parameters which indicate the direction and magnitude of the subsequent research and development program.

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DEVICE developed to absorb vibration utilizes foamed elastomer as an alternate to a metallic spring.

ENGINEERS examine traces on a strip chart to review data obtained in checkout tests involving sequencing.

• **Based on model analysis** results, cost figures, knowledge of relevant research, industrial capability and intelligence data, configurations which have marginal performance, low probability of achievement, logistic impossibilities or extreme operational difficulty are eliminated. Ideally, a single functional configuration can be chosen which will satisfy the specified values of the GOR. Practically, parallel configurations may be indicated, or one configuration may require backup effort in major subsystems.

• **Functional and parametric** configuration next is translated into a physical and geometric presentation. The results are block, interaction and circuit diagrams, inboard and outboard profiles, over-all kinematic and space layouts, major structural and interstage arrangements, crude weight and distribution summary and other physical summaries.

• **Research and development** program is blocked out. Plan attempts to give hardware equivalents of the configuration selected—and other elements of the weapon system, such as ground support equipment—complete logistic capability. This step involves such factors as definition of key problems and approaches to their solution and establishment of research objectives and development milestones. Guidelines to establish an operational concept, including such items as silo, GSE, mobility, transport and communication as well as technical budgets, test philosophy, gross test objectives and number of ground and flight tests. Preliminary programing and the number of missiles and subsystems are also delineated.

• **Development plan is drawn,** based on the research program, and submitted to Air Force. It describes the complete cycle, together with known hurdles, time and cost involved.

• **If Air Force decision** is favorable, next step is to parcel the system into main subsystem elements suitable for development by a contractor. STL writes the technical work statements for each of these subsystem areas, against which a group of competing contractors submit proposals. These technically detailed work statements generally are appendices to a request for proposals (RFP). Usually, prospective contractors are briefed formally on both the weapon system as a whole and on the content of the various work statements.

• **Technical proposals are** evaluated. These proposals also contain a separate recapitulation of the proposed "plan of attack." This permits the Air Force to accept STL's recommendation on the technical plan proposed as just one of a number of considerations that the Air Force must weigh, including cost, production capability and previous record of achievement.

Even though losing proposals may have distinct value in the subsequent research and development program, Ballistic Missile Division destroys these proposals, research and development director Duke revealed.

The detailed program plan which follows is largely a cooperative venture

ENGINEERING

IBM 704 COMPUTER permits General Electric engineers to analyze case stresses mathematically, correct design faults before fabrication begins. Computer is one example of advanced engineering capability which provides better case design, 230,000 psi strengths.

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between the contractors and STL. It allows the development plan to be reshaped to the particular capabilities (facilities, personnel, methods, production abilities) of the contractors chosen. Present procedure is for STL to outline the contents of the detailed program plans and for the contractors to write them.

This plan is the result of an extensive and painstaking effort. For example, the airframe portion might include a voluminous report on each of the following: design and engineering tests for missile verification, and ground support equipment; facility master plan; system test instrumentation; reliability program; R&D logistics; weapon system and airframe maintenance; engineering inspection and quality control; tools, jigs and fixtures; fabrication and delivery details; spares and supplies; operational logistics; subsystem integration; subcontracts; GFAE and GFE requirements; specifications; publications, reports and data; personnel, organizational and procedural plans; manuals, handbooks and data books.

It is STL's job to compare in detail the program plans of the various contractors, recommend adjustments between them and to approve the aggregate of such plans for USAF.

• **Program for development** of the weapon system is laid out. Production of missiles is divided into series, or "lots," and objectives are assigned to each lot. On-dock times and lead times for the various subsystems and for government-furnished equipment are established. Total number of missiles and subsystem hardware elements are firmed to ensure timed development of the weapon system.

• **Over-all test plan** is evolved. Spectrum of tests in development of a highly reliable ballistic weapon is very wide, starting with functional testing of the smallest part under environmental conditions and ending with actual flight test of the complete missile. Between these two limits there are component laboratory tests, aircraft tracking tests, rocket sled experiments, cold-flow laboratory work, shock tube research, drop tests and re-entry vehicle experiments, "battleship" and captive tests and operational system runs.

Each mode of testing has a definite maximum contribution to make. Each higher level of testing, which generally is more complicated and expensive than the preceding level, benefits by the buildup of testing at the lower levels. Interrelated results of all tests must be planned explicitly, as well as the feedback to the design process. Result of this give-and-take process and beforehand test programing is known as the over-all test plan.

• **Research and analysis** to "lead" contractors is based on the considerable

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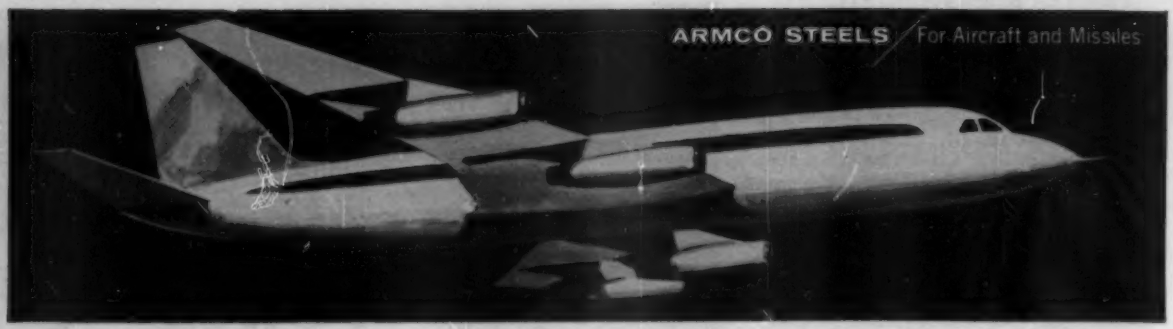

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amount of system analysis done before contractors come into the program. It is possible to foretell certain areas of difficulty which will be encountered by contractors and to perform, on a very long lead time basis, research to provide "on-the-shelf" solutions.

Examples are determination of sloshing phenomenon in the Atlas ICBM, the effect of shear stiffness and rotary inertia on Titan ICBM and effects on Titan and Minuteman of earth motion resulting from nuclear blasts.

• **Alteration and re-evaluation** of models will occur next. The variety of proposals and the impact of the details of subsystem program plans, which frequently differ in concept from STL's ideas, require reworking of many of the analytic models. Also, the test program is an exact verification procedure for the coefficients initially assumed, and if results are widely divergent from assumptions, some alteration in concept and program is indicated.

• **System and subsystem design** decisions are made, interfaces are defined, interface problems solved. Large number of major decisions in the program plan must be made later in the program. Particularly important to the systems contractor are those which interrelate various subsystems. Two types of interface solutions are involved: definition of an interface line, to the left of which contractor A works, and to the right of which contractor B works; the second is the optimum solution of interface problems, which frequently are design, functional or geometric conflicts existing between subsystems or major components. Important here is a complete objectivity and the lack of a product or dollar bias, Duke emphasized.

• **Acceptance criteria and procedures** are established. USAF customarily accepts the initial runs of all hardware as typical of the following units in the same lot. Criteria for this acceptance generally lie buried in the detailed equipment specifications. Acceptance runs must be as rigorous as possible to duplicate flight and operational aspects.

• **Results of system tests** are analyzed, weapon concept is refined continuously and parallel or backup efforts are eliminated when necessary. Because continuing advances in the ballistic missile art are a major concern of the Air Force, the systems contractor (STL) coordinates the various incremental advances. Thus, test results generally are primarily useful to validate the system design but, together with analysis and design development, they also can constitute a state-of-the-art advance. These advances must be fed back into the weapon system continually to obtain product improvement and growth potential. Large advances could result in a new general operational requirement. As the various developmental hurdles are overcome, re-

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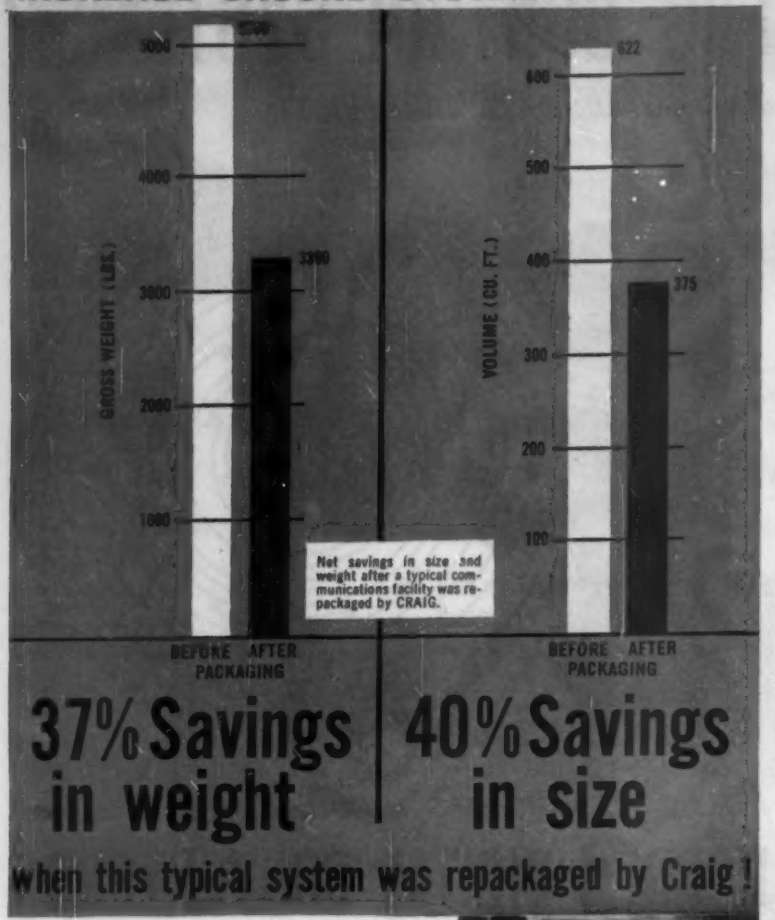

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Recently, Craig was asked to study a 'mobile' military facility, and repackage it. The result: 1900 pounds of unnecessary weight, eliminated. 246 cubic feet of unnecessary space, eliminated — the existing components repackaged in a modern, lightweight, high-strength Helicop-Hut® shelter – efficiency increased, handling and transportation made easier, faster, safer — time and money saved.

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After repackaging by Craig engineers in highly mobile Helicop-Hut, total weight has been reduced by 1900 pounds, total space has been reduced by 246 cubic feet. Antennas are packaged and tied down to floor for transit.

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search objectives achieved and successful demonstrations and flight are accomplished, the number of parallel or back-up efforts is reduced to zero.

• **Assist USAF in functionally** designing the operational system. This involves system engineering of the operational elements which complement the missile itself and is an engineering effort of the same magnitude as the effort required for all of the foregoing steps. These elements include ground guidance, launcher-erector, launch control equipment, checkout gear, ground power, missile transport system, perhaps hardened silos, system or targets and targeting methods, crews, maintenance doctrines. Interrelation between these various elements is established and issues adjudicated.

• **Detailed test plan is implemented** by establishing systems test methods. STL has technical responsibility for this testing, including planning detail in such areas as preflight ground test requirements, data evaluation in relation to succeeding flights, changes in subsequent flight configurations, solution of flight malfunction problems by captive testing, and certification of flight test objectives.

Flight test includes establishing the support requirements of the range, a test-control working group and its ground rules, a test documentation system including data acquisition and support plans for each flight; detailed test objectives, flight test directive and preliminary and final test evaluation. Generally, STL does not write the body of test documentation, data and review, but programs and sometimes outlines it. Other assignments include allocation of telemetry channels from flight to flight and assignment of radio frequencies for the various subsystems.

Systems engineering effort could lag and become ineffective quickly if it were not implemented and followed continuously by the systems engineering team, according to Duke. Natural tendency of a widely dispersed and competitive group of contractors is to diverge from a tight program plan. This tendency is accentuated by compressed time schedules fed into the programs by USAF, and the resulting tendency toward the use of brute-force solutions, conducting demonstration instead of research and development flights, and toward elimination of prerequisite testing and feedback into redesign, etc.

To ensure direct utilization of various program objectives and the continuing feedback required for proper alteration of the system concept, USAF has specifically delegated the technical direction function to STL. Overlap of this function with systems engineering is obvious. Highlights of the technical direction function include:

• **Implementation of the program plan.** This is done largely through technical direction meetings scheduled once a month, through written technical directives and through contract and work-statement changes.

Establishment of program dates, hardware-on-dock times, facility occupation dates, flight rating test requirements, acceptance dates and procedures and development engineering inspections, constitute a major effort in technical direction.

• **Making of systems decisions** and, with the various contractors, making major subsystem decisions. System decision might involve choice of a trajectory for optimum range, guidance accuracy, heat transfer, and re-entry stability. Another area might be the selection of a separation method for rocket stages.

Major subsystems decisions almost never affect only a specific subsystem but generally influence missile weight, system reliability or performance, or performance of an interrelated subsystem.

• **Defining technical interfaces,** implementing these dividing lines contractually and solving the interfaces. Interface solutions can involve large amounts of contractural work. For example, an interface definition by STL could involve the writing and implementation of a detailed power coordination and distribution specification—what power is generated, how it is distributed, which subsystem receives power during what portion of trajectory, etc.

• **Outlining and approving subsystem** integration plans. These extremely detailed agreements between associate contractors specify the logistics and responsibility during the R&D program. This phase directs the "how" rather than the "what" of the effort.

• **Directing the implementation** of the operational system. STL works with the Air Force to delineate the operational envelope. This blocks out the individual elements of the ground and support portions of the weapon system. The detailed operational concept that results must be incorporated into the R&D program, and development of associated production and logistic capabilities must be implemented.

ARDC-Europe Starts Human Factors Test

Air Research and Development Command's European office has undertaken a research study of the human nervous system and its possible application to computer design, according to Maj. Ralph O. Griffin.

Griffin, who is assigned to the European office, said a "study of the simple nervous systems" will become important if principles can be derived from such studies for design of computers. In another study under ARDC's auspices, Prof. J. Z. Long, of London is teaching octopuses how to distinguish between various remarkably similar letter-like shapes.

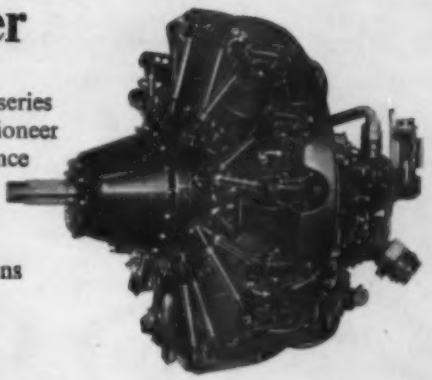
Other experiments reported to the group by Griffin are being conducted by Dr. Sem-Jacobsen, of Norway, a psychiatrist and neurophysiologist who is recording brain waves of jet pilots while in flight. By means of a technique of insertion of multiple fine electrodes, he has been able to contribute to understanding of subjective responses to brain stimulation.

A team from Institute for Theoretical Astrophysics at the University of Oslo is operating a station in Air Force Cambridge Research Center's Project Space Track which is expected to lead to a National Space Surveillance Control Center. The Center would have the job of detecting and tracking all artificial earth satellites. Project Space Track is now doing this on an interim basis.

In addition to developing techniques of space vehicle observation, the Norwegian group will maintain a 24-hr. a day watch for each orbiting vehicle which comes within telescope range of Oslo. Observations will be reported immediately to Project Space Track at Bedford, Mass, by a direct line.

More Power for the Twin Pioneer

The Alvis Leonides 530 series Engines give the Twin Pioneer an even better performance and greatly enhance its short take-off and rapid rate of climb, which are essential for operations in difficult country.



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Vertol selected to build new 2-3 ton transport helicopter

Vertol has been selected by the U.S. Army to develop a new 2-3 ton capacity helicopter, destined to write a new page in the mobility book of today's fast striking forces. This multi-turbine powered vehicle (Army designation the YHC-1B Chinook) is a growth version of the company-developed Vertol 107 family prototype.

The all-weather, day-night YHC-1B will be capable of performing such varied missions as redeployment, reinforcement, attack and pursuit. In a logistical role, the aircraft could transport missiles, nuclear warheads and general cargo, and evacuate casualties. Its unobstructed 30-foot long payload compartment, with a straight-in rear loading ramp that can be left partially or completely open or removed entirely to transport extra-length cargo, speeds the entry and discharge of men and materiel . . . and facilitates in-flight parachute or free-drop delivery for special missions.

The YHC-1B will not only be able to air-lift tactical units capable of completing assigned combat missions, but provide vitally needed mobility within the combat zone. This mobility is requisite in the concept of limited conflicts and, in addition, provides an important offensive and defensive weapon against nuclear attack. In a nuclear situation, the YHC-1B could provide the means for the prompt concentration of troops for attack and their equally rapid dispersion to negate effective retaliation.

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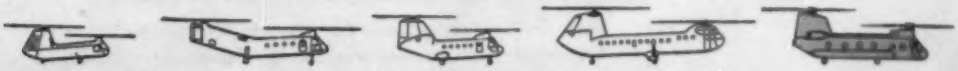

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VOLUME PRODUCTION

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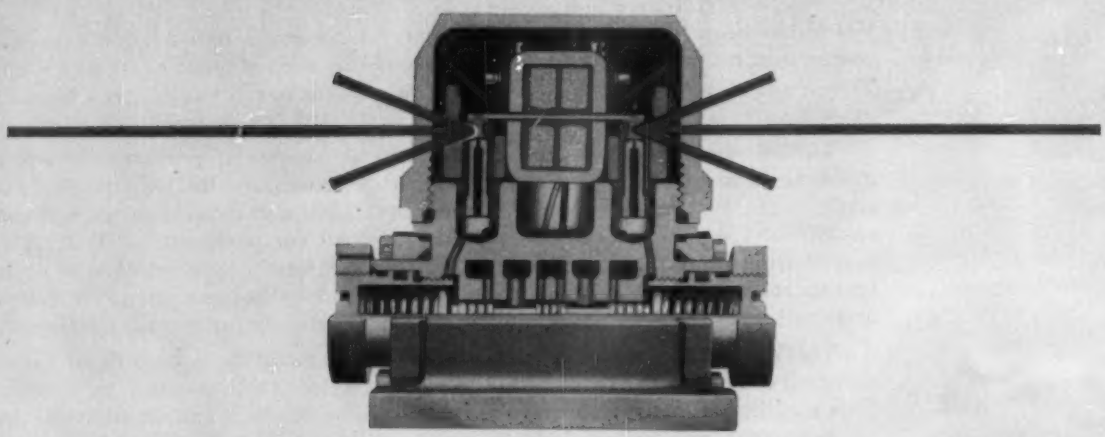

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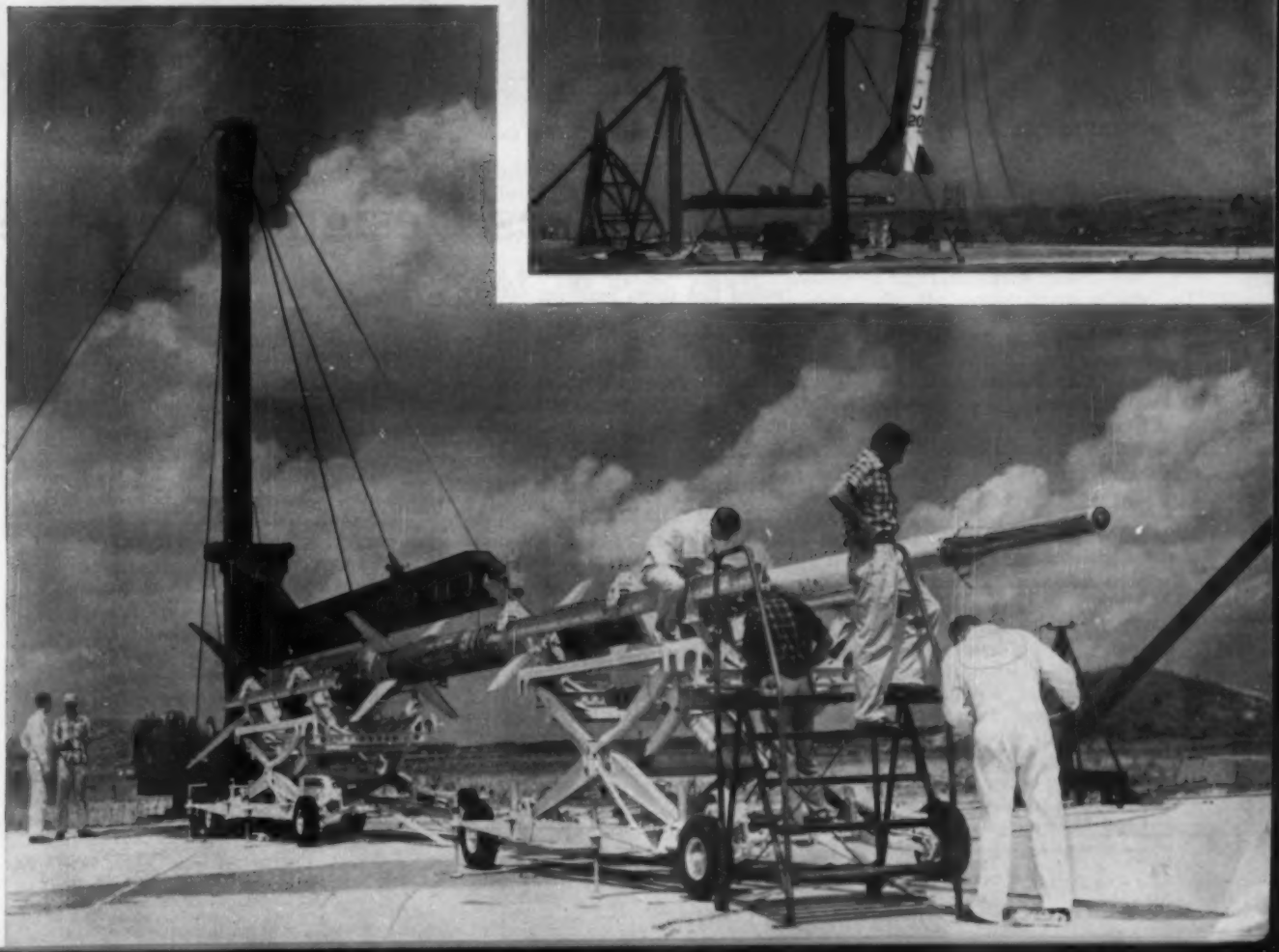
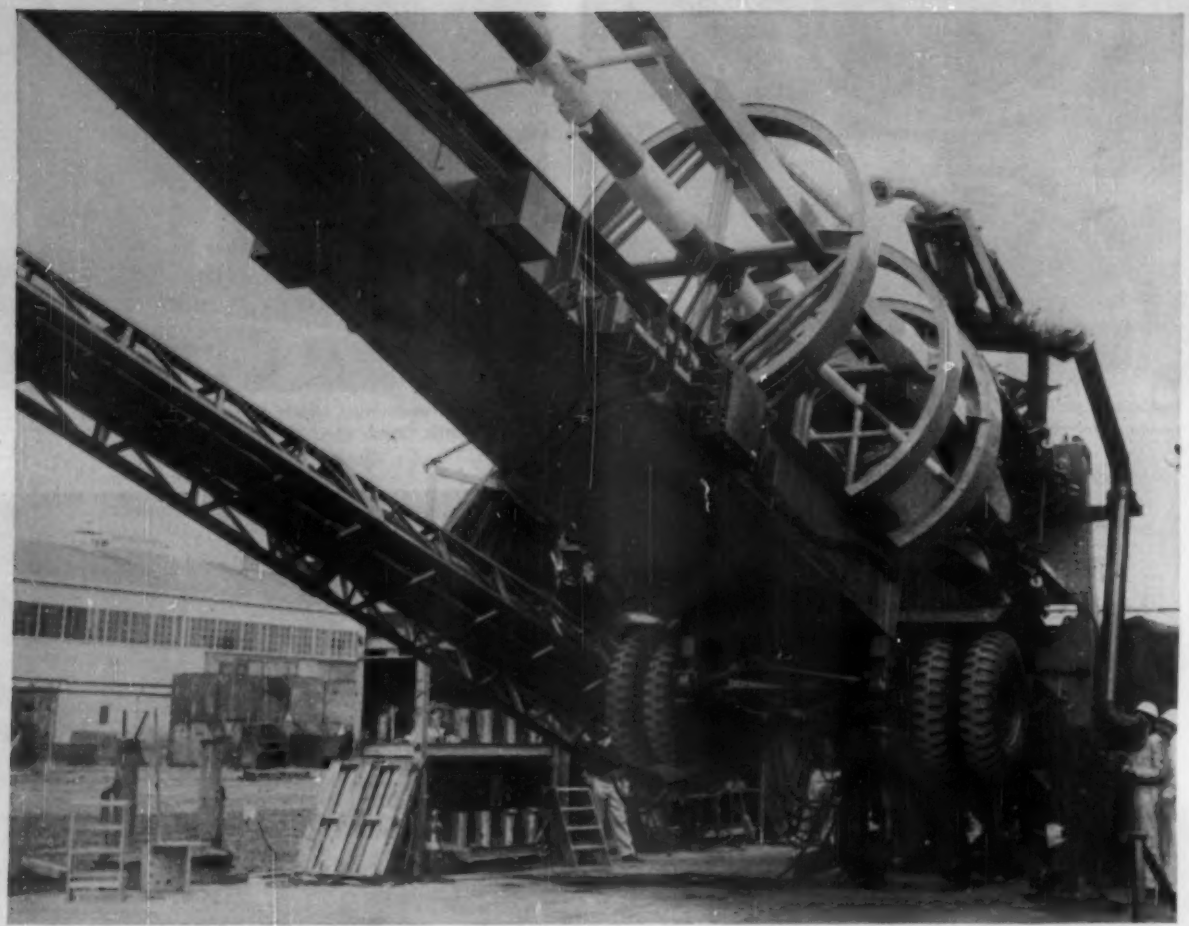
Instrument payload is attached to the fifth stage of Aerolab ARGO E-5 solid rocket for monitoring effects of high altitude atomic explosions in Project Argus (AW Mar. 30, p. 27). Rockets were launched from three Atlantic Ocean sites; 21 were fired in all.

Jason Solid Rockets Prepared for Launch

ARGO E-5 sounding rocket (shown at right at Wallops Island, Va., launch site) is an Aerolab Development Co. adaptation of a five-state National Aeronautics and Space Administration hypersonic re-entry test vehicle. Rocket at right is 20th on firing schedule; below, rocket does not yet have instrumentation stage attached for Project Jason.





PRODUCTION model of Thor ICBM transporter-launcher-erector has tandem steerable wheels with a driver position on each side.

Food Machinery Studies Design of Mobile

By William S. Reed

San Jose, Calif.—Missile launching sites of the future may be roving, mobile complexes of 10 to 12 vehicles moving about on an hourly or daily basis to keep an enemy from pinpointing them.

Roving squadrons would have the capability of maintaining missiles at a constant state of readiness while under way and would include checkout equipment, fuel tankage, limited spares stock and housekeeping facilities for the personnel manning the vehicles.

Such a system, according to Food Machinery & Chemical Corp.'s Ordnance Division, would not be as vulnerable as fixed or hardened bases, compared by some with France's ill-fated Maginot Line of World War II. The mobility concept would make a concerted, timed, sabotage attack much more difficult to coordinate, as well as the mounting of an all-out offensive, to destroy U.S. retaliatory capability.

Food Machinery is conducting feasibility studies on transporting solid-propelled first stages weighing 500,000 lb. —liquids of even greater weight—and is convinced that handling single units weighing up to 800,000 lb. is possible. Generally, units weighing in excess of 250 tons will not be transportable over conventional highways, and instead will use rail.

Guidance Hindrance

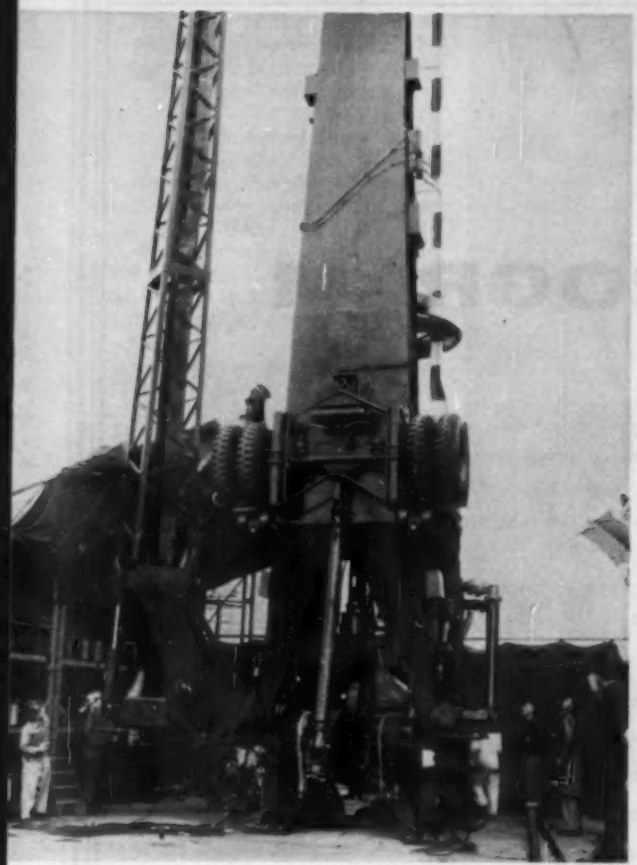
Present mobile launch capabilities are hindered by guidance systems which are incapable of coping with constant moving. However, it is not considered a too difficult task to modify guidance units so that they will automatically account for changes in launch position and compute new range and azimuth to the target.

Army, Navy, Air Force and Marines are behind Food Machinery's mobility theme, according to James M. Hart, executive vice president of the company and manager of the Ordnance Division. The concept is desirable from the military standpoint because the enemy cannot hit what he can't locate.

Food Machinery has proposed making the Douglas Thor WS-315A completely mobile by providing transportable propellant storage units and a portable lower launch stand instead of the present fixed installation.

Food Machinery has not built any hardware for the 10 to 12 roving vehicle project described above, but proposals for such a complex are in the advanced planning stage. Experience during the last 17 years as a supplier of tracked vehicles to the Army, plus present contracts for missile transporters and erectors, provides Food Machinery with the know-how and capability to design, engineer and produce such a system.

Products manufactured for the military services by the Ordnance Division presently account for 22% of the company's business. The remaining 78% is divided between three others: Chem-



PROTOTYPE erector unit (left) was fitted with dual rear wheels. At right, Thor production version uses dummy missile.

Missile Sites

ical Division, the Machinery Division and FMC International, which operates foreign subsidiaries and affiliates in Australia, Belgium, England, Canada, Spain and Mexico.

In addition to the defense business conducted by the Ordnance Division, Food Machinery's Chemical Division is a major producer of hydrogen peroxide for liquid-fueled rocket engines, and produces Dimazine, a rocket propellant chemical for liquid fueled engines. Dimazine is a trade name for unsymmetrical dimethylhydrazine. Food Machinery recently got into the solid propellant rocket business when one of its subsidiaries, Petro-Tex Chemical Corp. jointly owned with Tenessee Gas Transmission Co., acquired Grand Central Rocket Co. of Redlands, Calif.

Food Machinery & Chemical Corp. had a gross income in 1958 in excess of $323 million, a 3% increase over 1957. The increase is unusual, since in the recession year of 1958 most companies' gross income declined.

Food Machinery first became a subcontractor for Air Force business with the manufacture of transporter-erectors and launcher stands for the Douglas Thor and erector-launchers for the Boeing Bomarc. Thor ground support equipment production rate is five per month, while ground support equipment for Bomarc is turned out at the rate of 16 per month.

First Military Work

The corporation first became a military contractor in 1941 when it formed an Engineering Department for production of the LVT-1 Water Buffalo, an amphibious, tracked, assault vehicle. During the production run of the LVT-1, Food Machinery recommended several design refinements which improved the vehicle and facilitated production. Original design of the Water Buffalo was by Army Ordnance. Proposals were made to Army Ordnance for Food Machinery to design and produce subsequent vehicles. The improved version was successful and gave Food Machinery a footing in the military contract business. In 1950 the Ordnance Division was formed to replace the outgrown Engineering Department. The family of amphibious, tracked, personnel-carrying assault vehicles progressed from the LVT-1 Water Buffalo to the M-59 series, just now seeing completion of its production run. The next vehicle, the prototype of which was recently completed, is the M-113, an armored personnel carrier for the Army's Airborne Pentomic Division. The M-113 is constructed mainly of aluminum alloy and is air transportable, weighing in at approximately 18,000 lb.

Food Machinery got into the missile and space age business in 1956 and since then has built support equipment for Nike, Thor, Hawk and Bomarc missiles. Tactical firings of Thor have been from Food Machinery-built ground support equipment. Launchings of Lockheed's Discoverer from Vandenberg AFB, Calif., have been on Food Machinery-built erector-launcher.

The competitive scramble will undoubtedly get much rougher in the future since, as one Food Machinery official put it, everyone from small blacksmiths to the large prime contractors is trying to get into the act. As re-

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gards dollars, supplying ground support equipment is big business because, when a missile leaves its launch pad, anywhere from 70 to 90% of the money spent on the system is left on the ground. The percentage would become increasingly smaller, however, with subsequent firings.

Future plans do not all hinge around mobile launching sites. Food Machinery is researching the idea of producing tactical missiles much in the same manner that artillery shells are produced. One approach is completely automated production of solid propelled tactical missiles in large quantity with substantially reduced cost through mass production.

Food Machinery engineers worked with Douglas Aircraft Co. from the outset to design, engineer and produce the Thor transporter-erector launcher and power-controlled trailer.

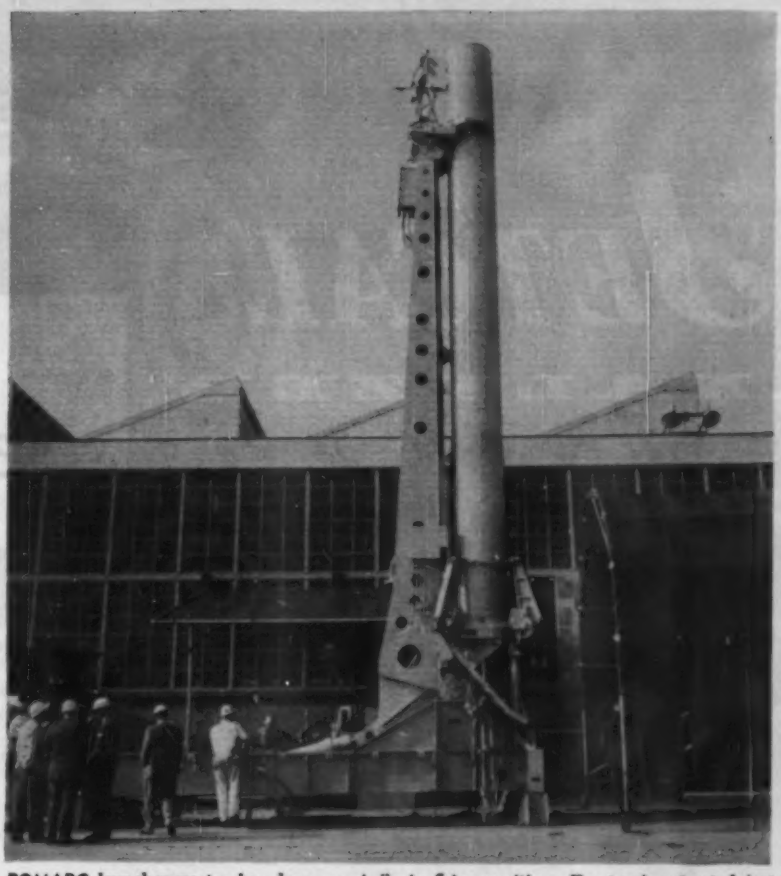
The Thor unit with umbilical boom weighs 56,000 lb. and can be towed by a standard military tractor vehicle. The prototype transporter was not equipped with steerable wheels and it was determined that considerable difficulty would be encountered in "navigating" narrow country roads. The production version has wheels arranged tandem fashion and provision for a steerer on either side of the vehicle in front of the wheels. Each set of wheels is steerable independently of the other and an intercommunication telephone is provided between the two steersmen and the driver of the vehicle to ensure coordination in negotiating turns.

Transporter's Spine

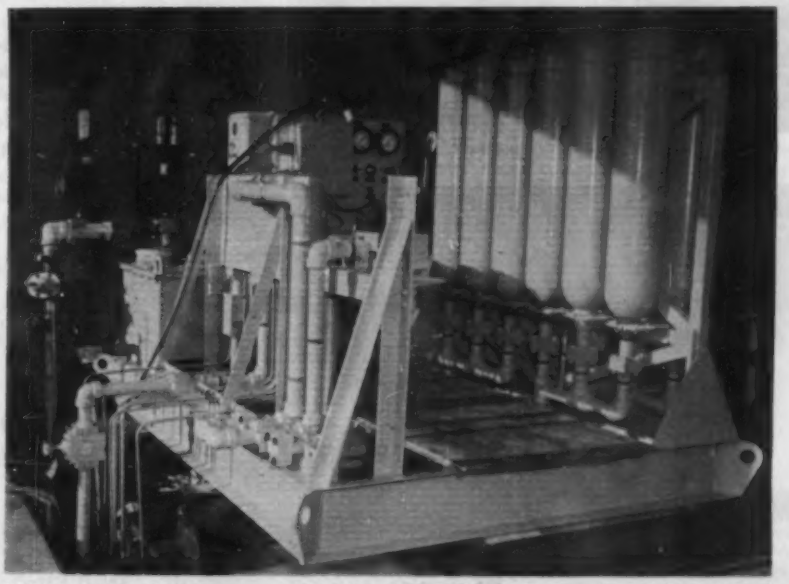
The spine of the transporter is constructed of prestressed welded plates and provides rigid support for the missile during transporting and erecting. Base of the missile is fastened at the rear of the vehicle, the upper portion being held by hydraulically-actuated clamps. A pad is provided at rear of the transporter to support the missile near its base. Rear support automatically provides the necessary pressure against the support bulkhead of the missile during erection so that bending moments are not introduced into the airframe.

At the launch site, the transporter is backed into position against a stationary launch stand and attached at two main trunnions. External electrical power is connected to the transporter to drive an electric motor which, in turn, drives hydraulic pumps to supply pressure for the actuation of the umbilical boom, erecting piston, upper hold-down clamps and support legs for the missile.

Upper hold-down arms grasp the missile nose firmly to prevent its toppling when the weight of the missile passes from trailer to lower launch stand. Hold-



BOMARC launcher-erector has dummy missile in firing position. Erector is retracted just prior to the launch. This unit is undergoing final testing and inspection before shipment from Food Machinery's Ordnance Division at San Jose, Calif. Equipment is designed to fulfill Bomarc's 30 sec. alert readiness stage.



BANK of 12 cylinders serves as hydraulic reservoir for rapid actuation of Bomarc steel enclosure doors and the missile's erector. High speed is necessary since Bomarc is a defensive, rather than retaliatory, weapon.

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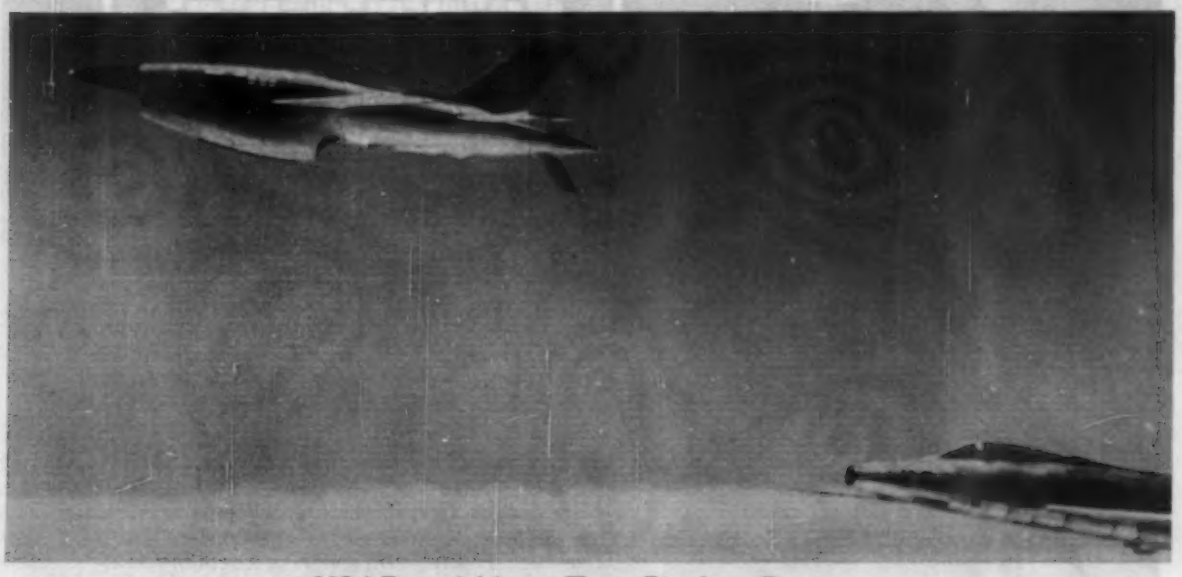
down arms are then opened hydraulically and the transporter lowered in preparation for checkout and fueling operation.

When the missile engine lights off and sufficient thrust is generated so that zero weight is borne by the lower launch stand, the umbilical boom retracts back 20 deg. from vertical and the missile support legs retract hydraulically. Despite heat and the corrosive effects of the rocket engine exhaust, little damage is sustained by the lower stand during launch. Food Machinery reports that one of its earliest assemblies has been used for six launches with little detrimental effect.

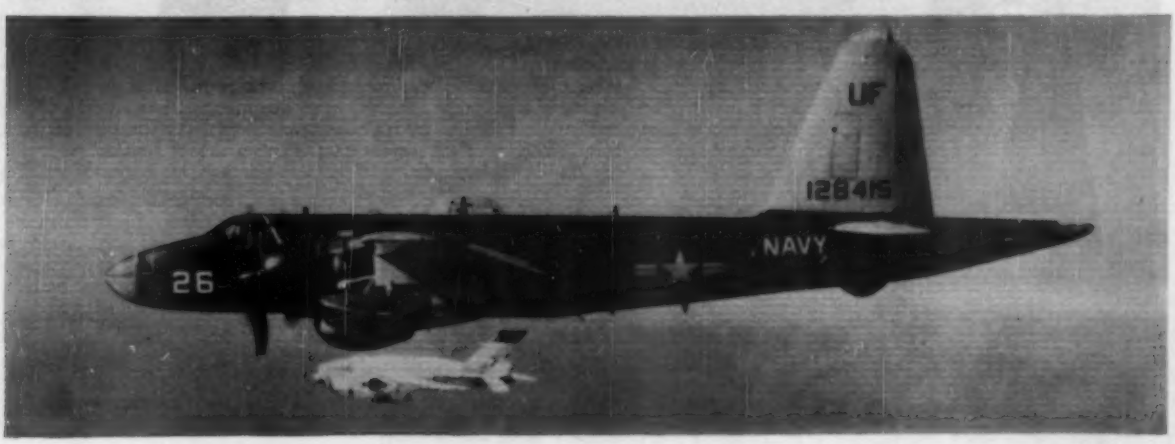
Food Machinery contends that extensive pretesting at its San Jose plant eliminated a great many difficulties which might have appeared in the field. An early testing program on the welded-steel umbilical boom revealed that deflection in excess of the allowable 16 in. was occurring under limit loads. Analysis of stress levels within the structure revealed no problem of yielding within the structure itself. However, an examination of the joints showed that excessive elongation was occurring in the bolts joining the sections of the mast. Redesign of mast joints resulted in satisfactory within-limits load tests and all existing masts were modified before delivery to the prime contractor. Other rigs were used by Food Machinery to test the launcher's main hydraulic cylinder piston rod and various other components under the severest weight and wind load conditions predicted.

Unlike the participation with Douglas in the design of Thor ground support equipment, Food Machinery subcontracted to Boeing Airplane Co. for a straight production run on the Bomarc launcher-erector and had no part in design or engineering of the system. However, Food Machinery did design and construct a decontamination unit by which the storage tanks for the various chemicals used in Bomarc's liquid-propellant booster can be periodically dumped and replaced. Chemicals involved in the booster are JP and UDMH, combination of which is referred to as JPX, aniline furfuryl alcohol (ANFA) and fuming nitric acid. Eighty-octane fuel is used for the Marquardt ramjets. Food Machinery-designed unit provides for dumping, flushing, cleaning, drying and refilling the propellant tanks without exposure

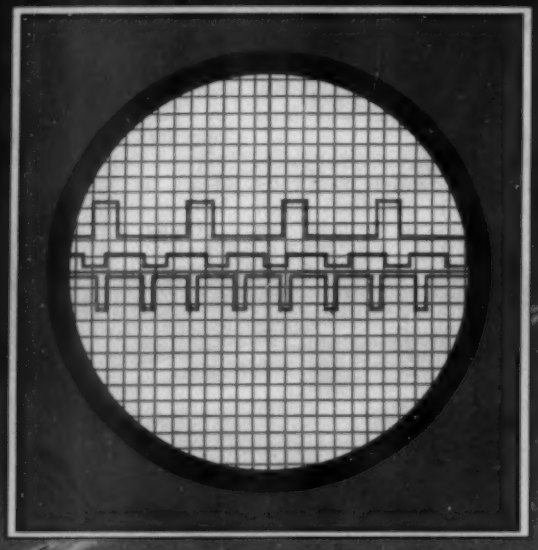


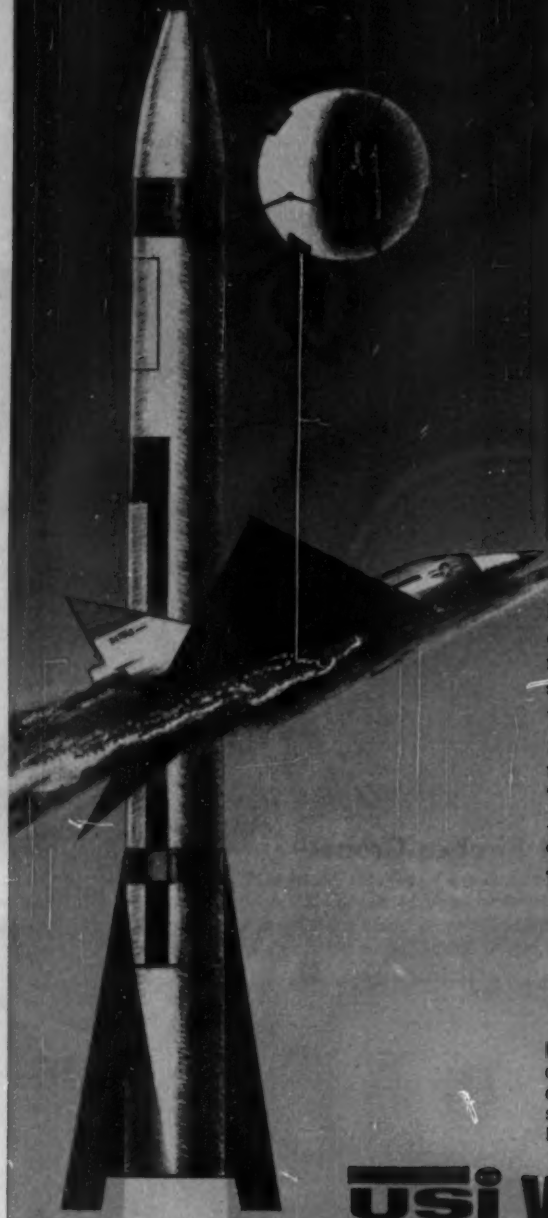
USAF and Navy Test Firebee Drones

Air Force's Ryan Aeronautical Co. XQ-2C Firebee turbojet drone (above) is chased by a North American F-100 Super Sabre over Holloman AFB, N. M. The target drone has attained altitudes above 50,000 ft. Powerplant of the XQ-2C is a Continental J69-T-29 rated at 1,700 lb. thrust (AW Feb. 16, p. 34). Below, a Navy-Ryan KDA-4 Firebee is dropped from a Lockheed P2V over the Pacific, off San Diego. The KDA-4, which is powered by a Fairchild J44-R-20 rated at 1,000 lb. thrust, flies at altitudes above 48,000 ft.



PRECISE PROGRAMMED TIMING





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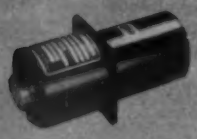

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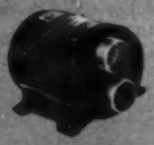

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danger to personnel. Decontamination of tanks, which is done about once every 60 days for each missile, is handled remotely from a control panel.

The erector-launcher for Bomarc bears a slight family resemblance to the Thor ground support equipment but similarity ends with this slight resemblance. Bomarc ground support equipment is hydraulically powered, as is Thor, but since Bomarc is a defensive rather than a retaliatory weapon, greater speed in erecting and launching missile is required.

The interceptor missile can be brought repeatedly to the 30-sec. alert stage while still housed in its steel enclosure. Food Machinery-built equipment must therefore be capable of sliding back the steel enclosure doors, erecting the missile and positioning it for launch within the required 30-sec. period. The rapid speed with which the missile is brought into firing position is achieved through use of 12 accumulators which store hydraulic pressure for fast actuation of enclosure doors and erector.

Success in the production, engineering and fabrication of Bomarc A erector-launchers has led Boeing to accept Food Machinery's design for Bomarc B erector-launchers. Bomarc B ground support equipment exhibits a much cleaner design than does the A launcher, due mainly to the fact that Bomarc B will have a solid propellant booster.

The solid booster will eliminate a great deal of the plumbing necessary for storage of liquid propellants used in the A model. The same design philosophy is employed in the B launcher including use of hydraulic accumulators for rapid actuation, but the whole system is much less complicated because storage requirement for liquid propellants is eliminated.

The Ordnance Division of Food Machinery is spending a great deal of time studying future applications of the company's resources to the fulfillment of military requirements. A large number of personnel is engaged in "applications engineering" in an effort to determine Ordnance Division's capability of manufacturing ground support equipment, not only for military requirements, but also for components and complete ground support equipment units in the forthcoming space exploration field. Food Machinery engineers told AVIATION WEEK that bidding on ground support equipment is highly competitive. One contract on which Food Machinery bid recently had no less than 32 individual subcontractors vying for the job. However, the entire resources of Food Machinery & Chemical Corp. are behind the Ordnance Division which puts the company in a very favorable position when bidding against competitors.

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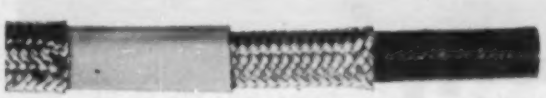

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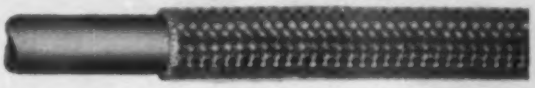

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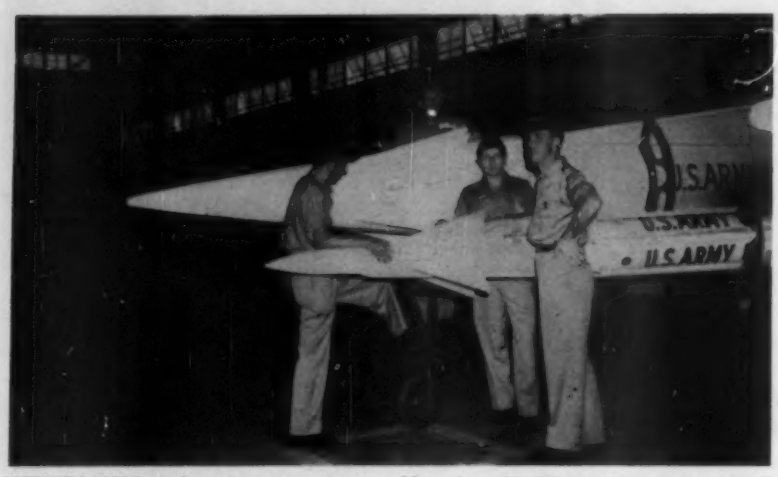
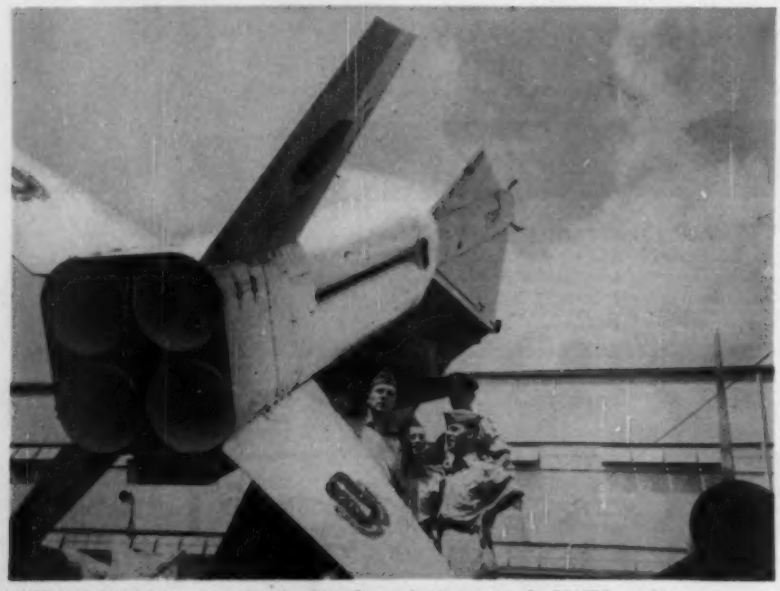
Missile School Aids NATO Combat Teams

By Evert Clark

GUIDED Missile School plant at Redstone Arsenal cost $100 million, includes new specially-designed classroom buildings (foreground). About 7,500 students will be graduated this year.



NETHERLANDS air force troops are among soldiers from NATO countries at the school.



NIKE HERCULES is mounted at hardstand area for inspection by NATO students.

Huntsville, Ala.—Fast growth of the Army Ordnance Guided Missile School provides an excellent index to the impact that missiles are having on U.S. and North Atlantic Treaty Organization military forces.

The six-year-old school, located in a modern $100 million plant at Redstone Arsenal here, will graduate about 7,500 students this year—almost as many as it did in its first five years.

It doubled in size last year, pushing its payroll from $9.14 million in Fiscal 1958 to $15.78 million in the current fiscal year—and the payroll is expected almost to double again in the forthcoming fiscal year, to exceed $27 million.

Early in 1953 the school was created under the Ordnance Training Command to give technical training to U.S. Army enlisted men, officers and a few civilians in maintenance, inspection, repair and supply of missiles and their ground support equipment, and in storing, issuing and inspection of propellants and explosives. Its mission goes beyond this individual training to include formation, training and activation of guided missile units.

International Center

Since then it has become an international training center. Classes have come from 11 NATO nations and Nationalist China. USAF Jupiter intermediate range ballistic missile squadrons are being trained here now, and the school in the past has trained U.S. Marines on the use of the Lacrosse surface-to-surface missile and Navy personnel in the general field of ballistic weapons, using the Corporal and Redstone to give them experience leading to their use of the Polaris missile.

This growth is expected to continue at somewhat the same rate in the near future. NATO training—limited until recently to the Nike Ajax and Nike Hercules anti-aircraft missiles—will be broadened to include ballistic systems ranging up to the Jupiter as the U.S. attempts to make NATO forces increasingly self-reliant in the missile field. Southeast Asia Treaty Organization nations eventually may swell the ranks of international students even more.

Missiles for which courses are being given now include the two Nikes, the Lacrosse, Corporal, Redstone, Jupiter, and the Hawk low-level anti-aircraft missile. Courses for the Sergeant, successor to the Corporal, are now being documented, and some top-level indoctrination is being done on the Super Hawk. The school also has been directed to prepare for training on the

Pershing, successor to the Redstone. The New Missile Intelligence Branch of the school's Research and Curriculum Division, which monitors missiles from concept until resident instruction begins at the school, already is following the short-range ballistic "Missile A," the Mauler anti-aircraft missile and Nike Zeus anti-missile missile system.

Personnel Needs

As the Army's over-all personnel strength continues to drop and the use of guided missiles continues to expand rapidly, the task of finding skilled personnel with long enough tours of duty to be useful, to organize courses and train these men, and to follow and allow for the constant revisions and modifications in missile systems, has been a tremendous one.

Remaining flexible enough to meet these shifting conditions is the toughest job the school has, officials say. This involves guessing ahead on funds and numbers and types of personnel that are likely to be needed, documenting missile systems that haven't yet come into being, getting enough equipment to train with when it is at a priority for use in the field, finding time to maintain the training equipment when some courses are run on a three-shift, 24-hr. a day basis, etc.

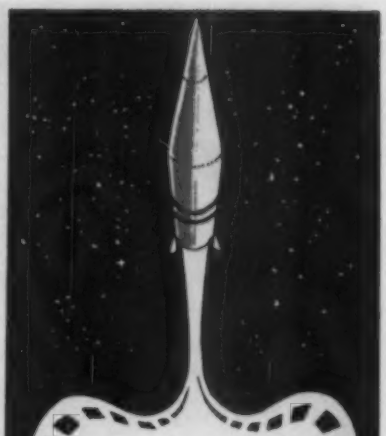
Growth alone has called for astute planning. Under the command of Col. H. S. Newhall, the school's faculty, staff and permanent administrative and maintenance personnel now total about 2,076. This is almost double the figure one year ago. Of the 2,000, a few more than 1,700 are instructors.

Although 12,725 students had been graduated through the end of last year, the rapidity of the school's growth can be seen best by comparing the graduate figures for the last three years and the expected total for the current year—some 1,800 in 1956, 2,500 in 1957, about 4,500 last year and 7,500 this year.

Biggest growth is still to come, in Fiscal 1961, when the school expects to activate 47 tactical ordnance missile support units, compared to 25 for Fiscal 1960, 23 in the current fiscal year

SCHOOL makes wide use of visual aids and closed circuit television, now is conducting 16 courses on Army-developed, USAF-deployed Jupiter weapon system.

TELEVISION camera trains on instructors and Firestone Corporal as part of closed circuit network. Special reports also are telecast to Army commanders in the Pentagon.



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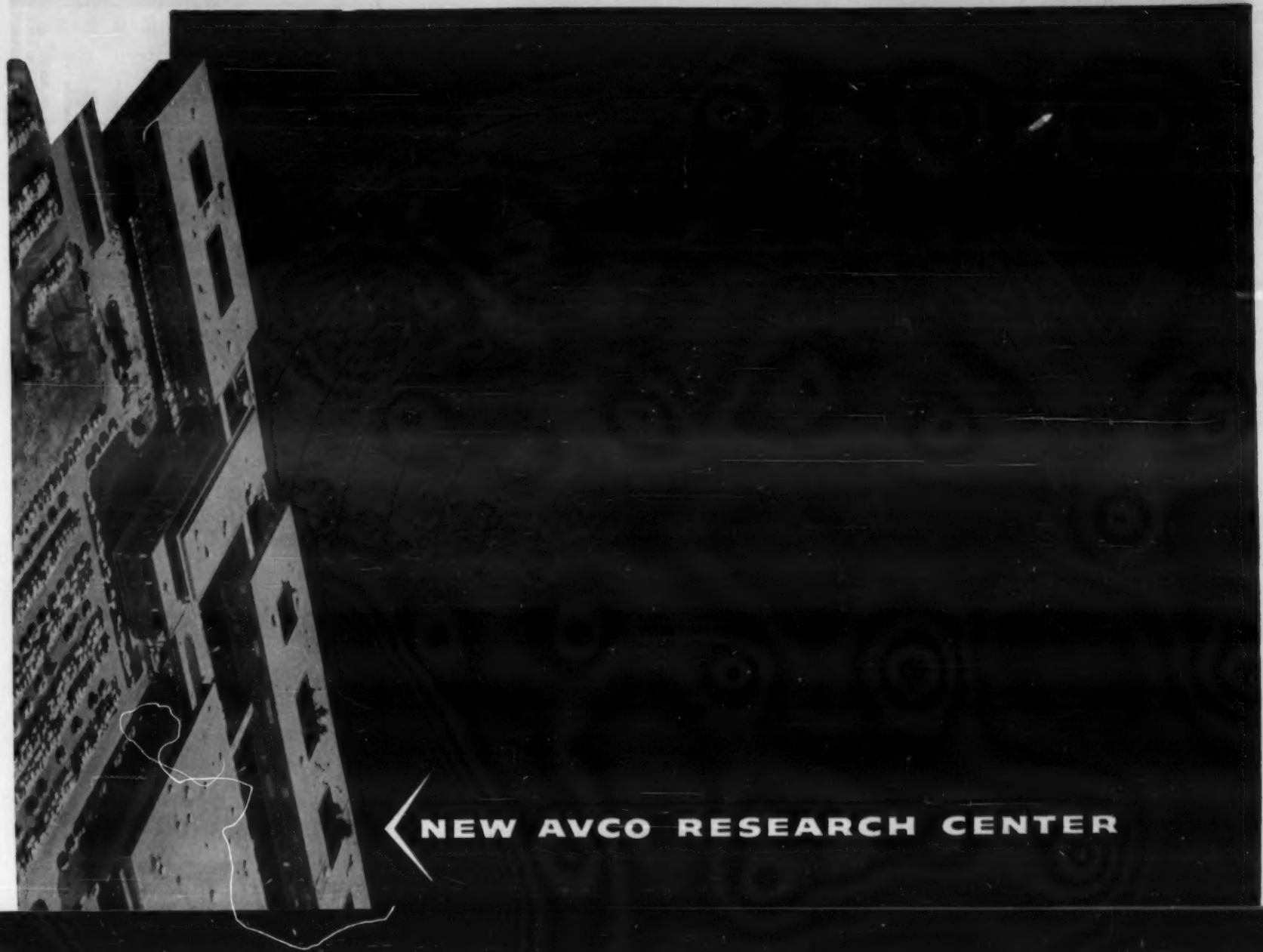
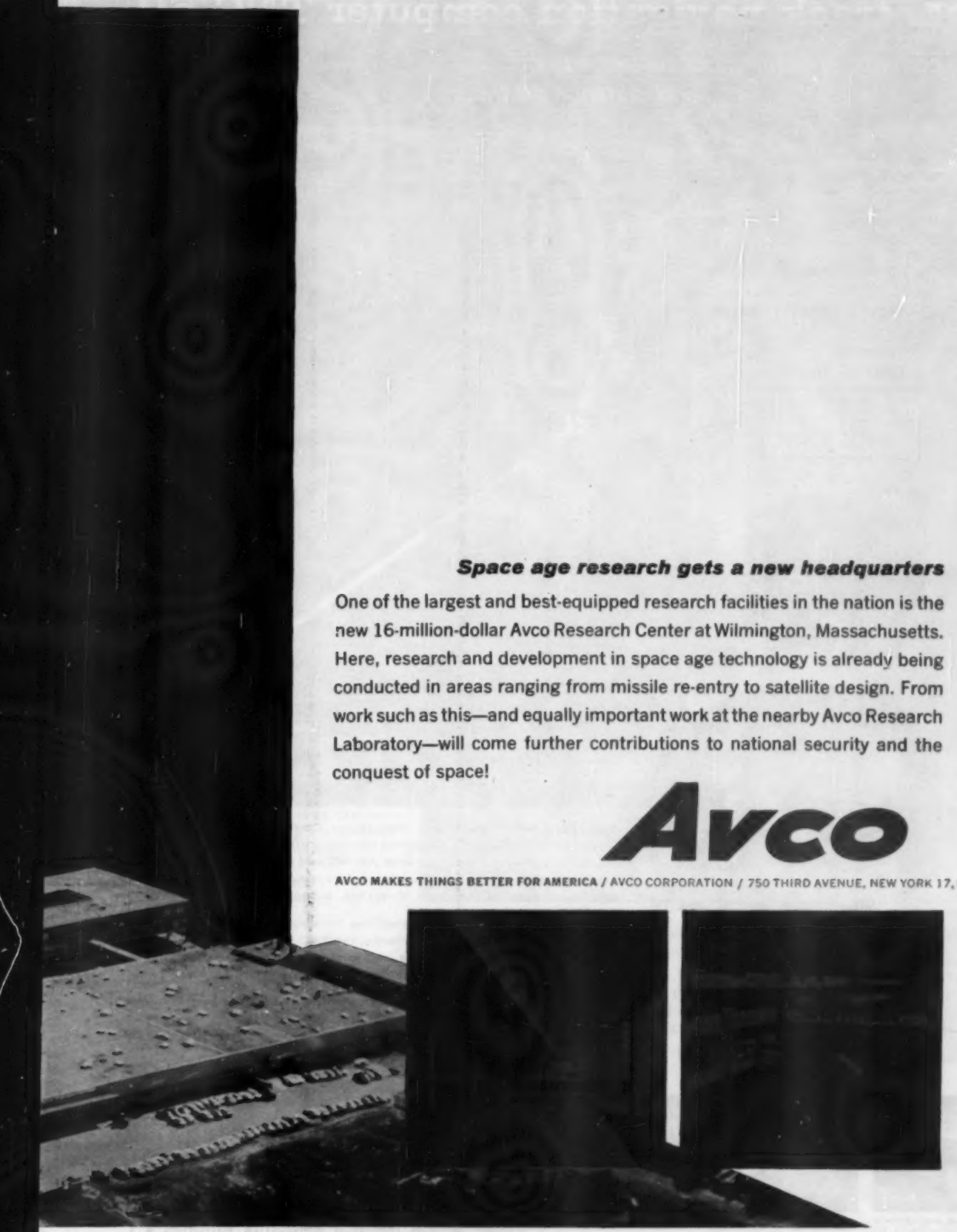

NEW AVCO RESEARCH CENTER



Space age research gets a new headquarters

One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted in areas ranging from missile re-entry to satellite design. From work such as this—and equally important work at the nearby Avco Research Laboratory—will come further contributions to national security and the conquest of space!

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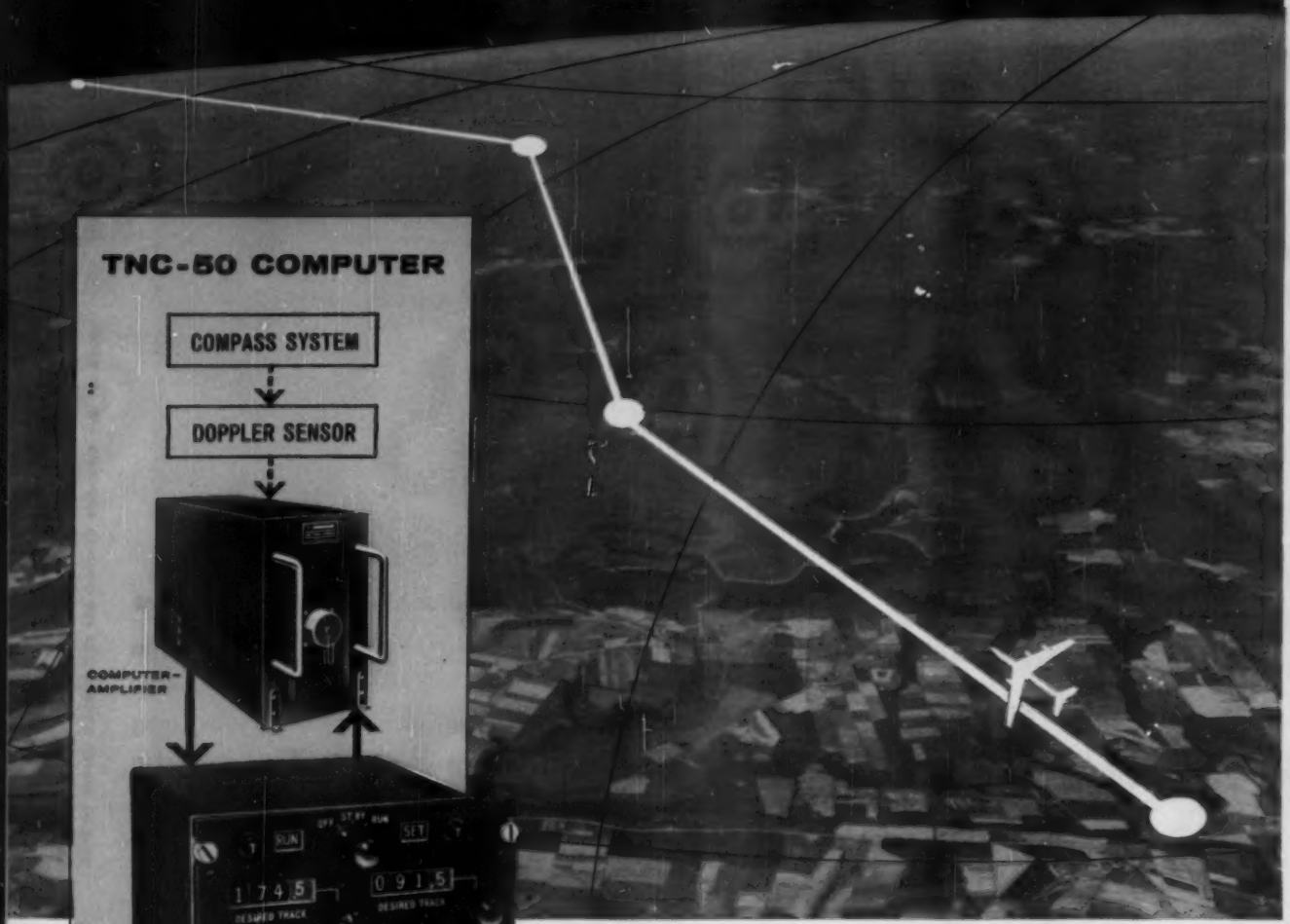
GPL track navigation computer TNC-50

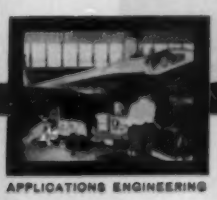
continuous readings of distance to go and distance off track...



TNC-50, GPL's new Track Navigation Computer, provides direct outputs of distance to destination and distance left or right of track. Designed to function with ARINC and other Doppler sensors, and any modern aircraft heading reference, the TNC-50 provides additional outputs for flight directors, autopilots, and attachments.

REALISTIC APPROACH: Utilizing the concept that a flight plan is composed of one or more segments, the TNC-50 provides continuous progress displays of ***distance*** and ***deviation*** along these segments, thereby eliminating complex latitude-longitude instrumentation.

THE RESULT: a compact, accurate computer providing continuous visual and command information to the pilot, and steering information to the automatic flight controls. Write for further data on the TNC-50 and GPL's new ARINC Doppler sensor, RADAN® 500.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and 11 U.S. and four NATO units in Fiscal 1958.

The degree to which missiles are coming into the European arsenal is evident from the number of NATO troops which have completed training here and gone on to Ft. Bliss, Tex., for battalion training—about 200—and those in training here now—about 500.

Since almost all NATO students are being trained only on the Nike air defense weapons, the NATO roster also gives an interesting picture of how that mission is assigned to different services in different nations.

Forming battalions of approximately 50 each, they are the nucleus who will return to their own nations to train others. All but the Italians, Danes and Norwegians are still in training here. Total NATO program to date is:

- **Italian air force**—110. These troops began training in November of 1957, completed the individual academic courses and four months of unit training here, progressed through Ft. Bliss, and returned to Italy about the middle of last January.
- **Danish ordnance corps—40.** This corps is a part of the Danish department of defense, serving all Denmark's armed forces.
- **Norwegian air force—40.** These troops were changed from Army to Air Force while they were at Redstone. They and the Danes completed their training here late last year and spent the Christmas holidays voluntarily maintaining equipment here during the holiday shutdown. They are now at Ft. Bliss.
- **Belgian air force**—40.
- **French army and navy**—40.
- **Canadian army** (Royal Electrical and Mechanical Engineers) — 50. These troops have trained on the Lacrosse and are beginning training on the Hawk.
- **British army**—50. This does not include British troops being trained by the U. S. Air Force in the use of the intermediate range Thor.
- **Netherlands air force**—40.
- **Turkish army and navy**—total will be 110. Second cycle of Turks and French is in training now.
- **German luftwaffe**—110.
- **Greek air force**—40.

Nationalist China also has 25 men in training as the first Asian country to use the Nike Hercules.

Training Schedule

NATO trainees are allowed from 25 to 50% more time in training than U. S. students, depending on prior training, the course and their familiarity with the language. Some attend courses with U. S. classes, some are kept together as NATO classes.

Selection of NATO students for U. S. training is left to the home nation, although all selectees must meet basic

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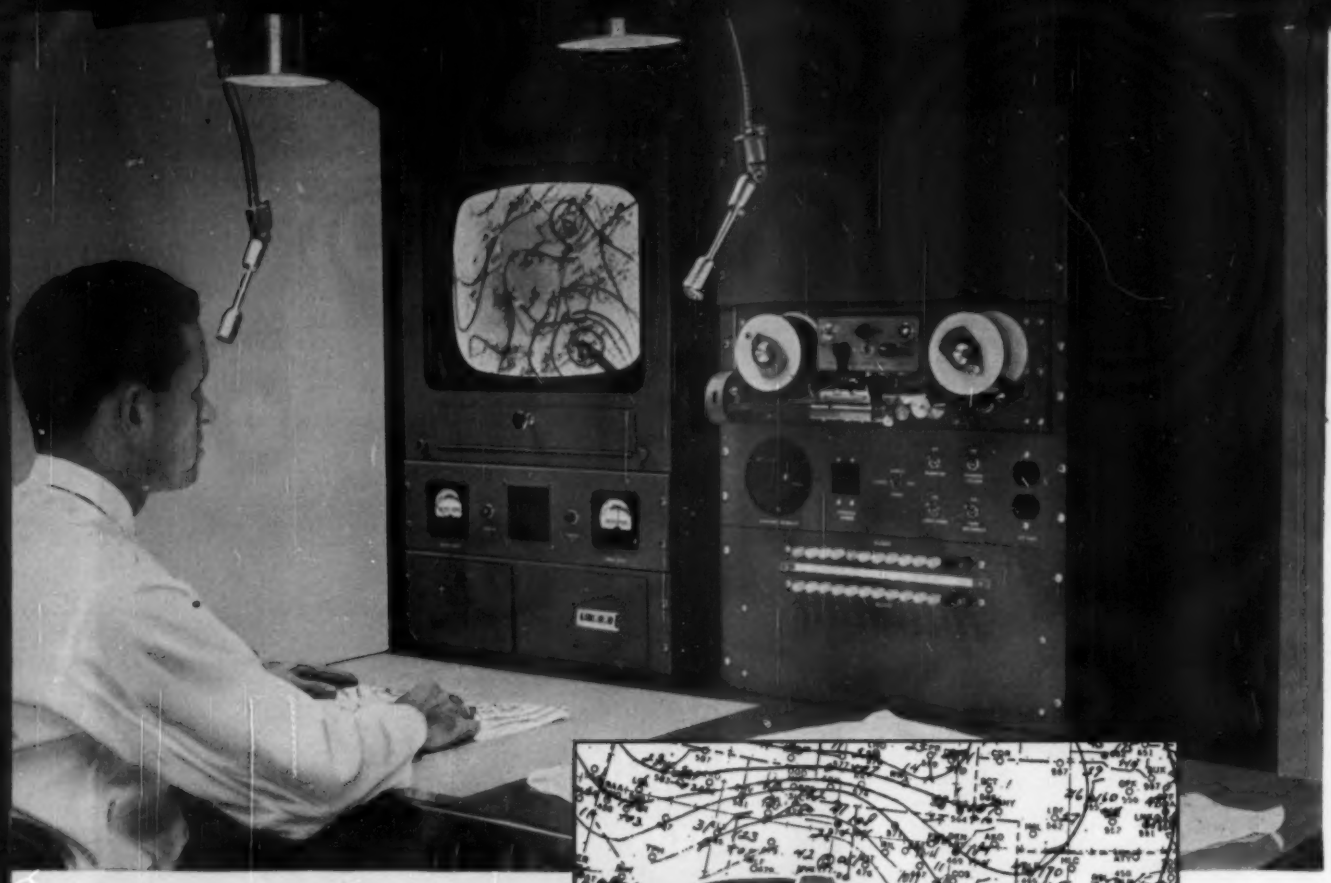

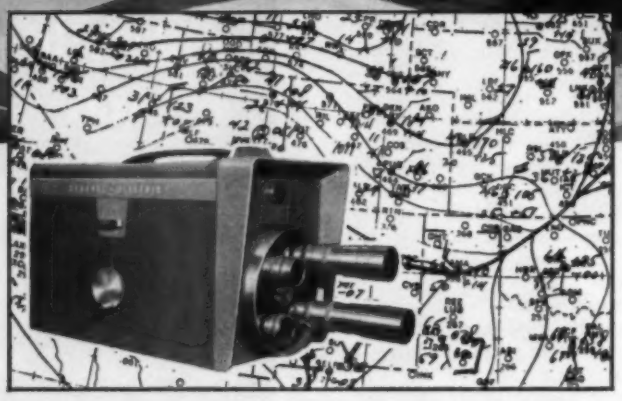

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requirements of the school. A great number speak English. Groups from non-English speaking nations include interpreters. Some of these interpreters have studied in the U. S. before and there are even two here now who have taught in the U. S., one at Massachusetts Institute of Technology and one at a training command school at Aberdeen, Md.

Some in each NATO group are training instructors who will handle follow-up training of the troops they accompany and training of other NATO personnel, with the help of U. S. Military Assistance Advisory Groups, after they return home.

NATO enlisted men live at the arsenal. About 95% of the officers live off the post. Huntsville, with a population of some 70,000, has shown great friendship for the NATO students, whom the townspeople call "the NATOs." The NATOs have taken University of Alabama extension courses, organized soccer leagues, eaten holiday dinners in Huntsville homes, and in one or two instances, married local girls. Apparently their biggest problem, aside from being away from home, is getting used to American customs.

One West German, practicing Western-style fast draw in a sand pit recently, shot himself in the leg.

The school's curriculum now consists of 47 courses, including 16 added last year to train USAF troops in the handling of Jupiter. Since Army Ballistic Missile Agency here has the national mission for training on Redstone and Jupiter, the school is conducting the Jupiter training for ABMA to requirements originated by Strategic Air Command.

Varied Courses

Courses range from the one-week orientation on ballistic missiles to as high as 56 weeks. Examples of the types of courses and their lengths are:

- **Nike anti-aircraft**—Launcher control system repair course, seven weeks; acquisition radar and component systems repair, 17 weeks; tracking radar systems repair, 20 weeks; internal guidance systems, seven weeks; mechanical systems repair, six weeks. These are all enlisted specialists' courses. Officers take a 20-week course and maintenance supervisors, who usually are warrant officers, a 43-week course.
- **Corporal artillery missile**—Doppler systems repair, 10 weeks; computer systems repair, 13 weeks; radar systems repair, 15 weeks; internal guidance systems repair, 11 weeks; mechanical systems repair, seven weeks.

A high ratio of faculty and staff to students is maintained, with classes running 12 to 20 students, because of the complexity of the subjects and the constant need for maintenance of the training equipment.

Every missile system has space on a hardstand directly behind the classroom building and in training shops directly behind the hardstand. Time is divided between textbooks and practical exercises in ratios from 50-50 to 75-25, depending on the system.

The school has several sources for obtaining instructors—at present it has about 364 civilians, 176 officers, 543 enlisted men, 314 missile contractor employes, and 331 men in a Signal Corps detachment. The school also keeps some promising graduates on as instructors.

Although there always is a shortage of good instructors, missiles have attracted teachers as well as trainees in the Army because the Army has staked a good part of its future on this type of weapon.

Electronics Course

Since trainee requirements are fairly stringent—anyone taking the electronics courses, for example, must have completed the 11-week basic Signal Corps electronics course at Ft. Monmouth, N. J.—the school has found that from 300 to 400 of its staff or students at a time are enrolled in the University of Alabama's extension courses. The

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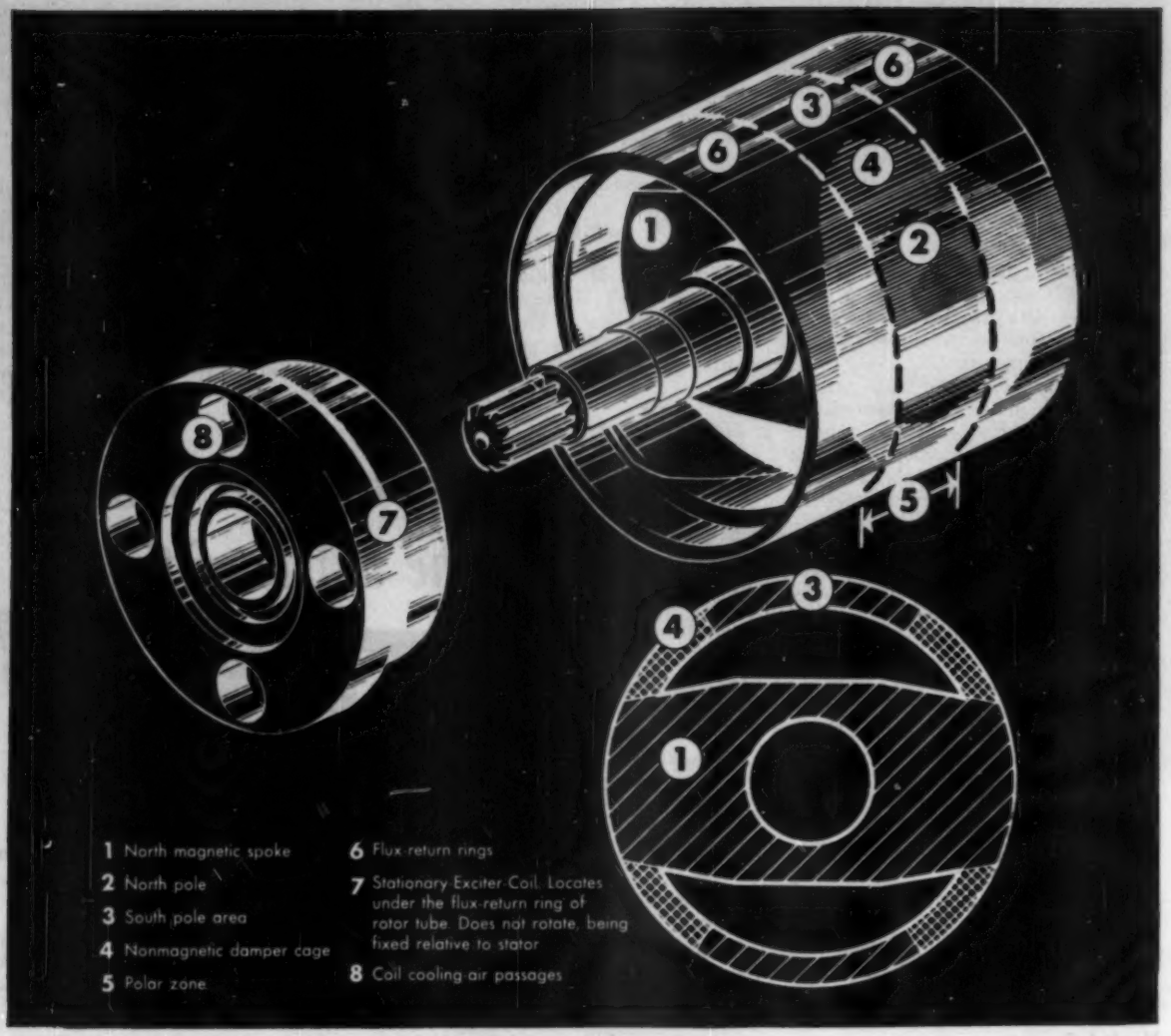
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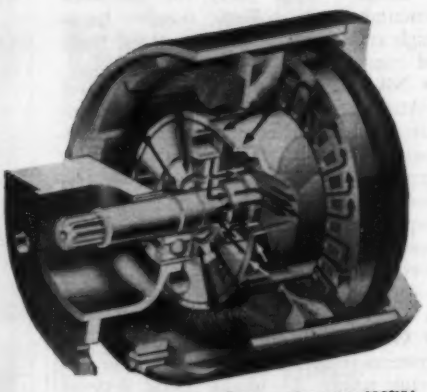

Cutaway of complete SECSYN showing flux paths.

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SYSTEMS FOR AIRCRAFT, MISSILES AND GROUND SUPPORT

school has a registrar, a secretary instead of an adjutant, and an educational adviser who is called "the dean." It makes the claim that its officers haunt the library instead of the officers' club, and its enlisted men read physics, chemistry and propulsion texts instead of comic books.

Attrition rate for missile units in the field still is some 40% for enlisted men and 25% for officers, with a good percentage of them going to comparable jobs in industry, which requires a great deal of replacement training. Trainees need a minimum service time of about three years to complete all training and still serve a year overseas. Army tries wherever possible to get career men from conventional ordnance work and make missile repairmen of them.

Courses Begin Early

New missile courses are born almost as early as the missiles themselves. From the first time that mention of a new missile system is heard, the New Missile Intelligence Branch of the Research and Curriculum Division begins to follow the weapon through feasibility studies, research and development, testing, etc., gathering information from developing agencies, contractors and the command that will use the weapon.

By keeping up to date technically and doctrinally on a weapon system, the division can evaluate the information, produce training requirements, write job descriptions for individuals who support the system, and from the job descriptions, formulate training courses.

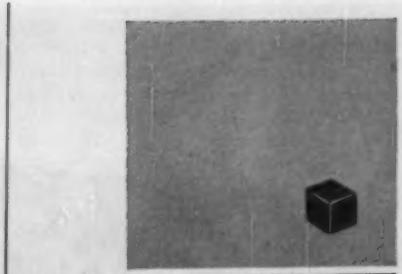
Contractors keep from one to half a dozen liaison men at the division per missile system, usually beginning when the intelligence branch is documenting courses. Latest changes in a system are taught in the school even before the modified hardware reaches the field. New hardware, like new information, comes to the school before it is supplied to the troops.

Nucleus of Instructors

A nucleus of instructors for a new system is formed when the contractor begins teaching "Key Personnel Courses" to a handful of officers and enlisted men, usually at the school site but sometimes at the contractor's plant.

The Research and Curriculum Division and the Training Division, which conduct the classroom and shop instruction, monitor courses and conduct field follow-ups to continually improve courses. Ordnance Training Command also follows the course of missiles and their operators after they are deployed and feeds back information that leads to improvements.

The school's most unusual assignment so far has been the operation of



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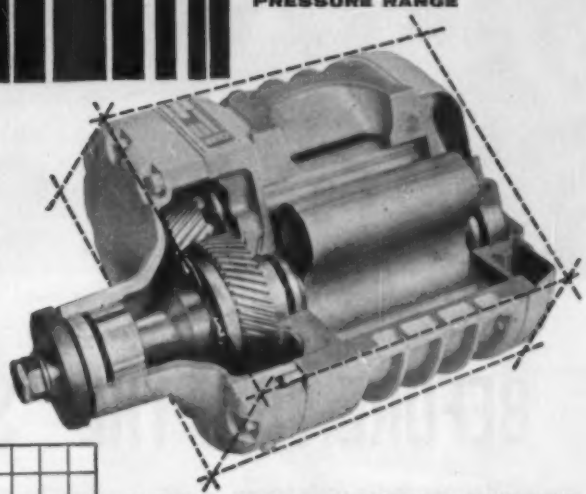

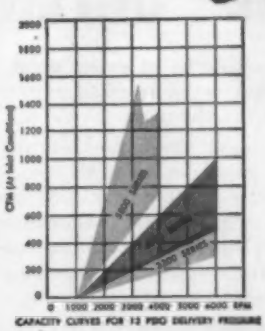

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an educational television station, both for in-school and long distance training. Since last October it has piped a two-hour course in missile readiness inspection to the Army Armor School at Ft. Knox, Ky., three times a month by closed circuit, saving an estimated $11 million by eliminating the need to duplicate equipment and instructors at Ft. Knox. The school expects this network to grow to other military centers where phases of guided missile training are given.

Since missile systems so far have tended to be mainly additive, rather than replacements for previous systems, school officials do not feel their mission has yet reached the plateau it may begin to hit when Pershing and Sergeant training fully replaces training on the Redstone and Corporal systems.

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U. S. Air Force contracting offices:

HEADQUARTERS, AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, AIR RESEARCH AND DEVELOPMENT COMMAND, Washington 25, D. C.

Massachusetts Institute of Technology, Cambridge, Mass., continuation of research on "Heat Transfer Characteristics of Diffusion Boundary Layers," (AF49(638)-245), $203,510.

The Trustees of Princeton University, Princeton, N. J., continuation of research on "Investigation of Fundamental Concepts in Theoretical Physics," (AF49(638)-304), $81,460.

Reaction Motors Division, Thiokol Chemical Corp., Denville, N. J., continuation of "Research on the Influence of Ions on Rocket Combustion Processes," (AF49(638)-305), $54,024.

Pilot Reaches 200,000 ft. in Chamber

Capt. Robert Rushworth, U. S. Air Force backup pilot for the North American X-15 research vehicle, reached more than 200,000 ft. in the USAF Flight Test Center altitude chamber, clad in this MC-2 full pressure suit. Altitude mark was set during a check of the regulators which control suit and breathing air pressures. Simulated flight took 20 min. The suit, which has an aluminized exterior to resist radiant heat, maintains pressure at roughly one third less than sea level. Suit is individually fitted.

Radiation Threat Increases With Altitude

By James A. Fusca

Washington—Concept of employing manned bombers flying at very high altitudes to deliver an attack on an enemy nation is the subject of a sharp controversy here. The reason is that these aircraft and their crews would appear to be extremely vulnerable to the radiation effects produced over great distances by large nuclear explosions in the upper atmosphere.

The radiation from two megaton-sized hydrogen weapons exploded at very high altitudes over Johnston Island as part of Project Hardtack last summer reportedly was sufficiently intense to produce almost a 100-fold increase in the ionization of the upper atmosphere at a range of 1,500 mi. from ground zero.

The results of these tests have opened for speculation—if weapons of this type were to be deployed as part of an air defense system—the possible obsolescence of the present Strategic Air Command inventory of manned bombers, as well as such weapon systems now in the research and development stage as the North American B-70 chemically-fueled bomber and the Dyna-Soar hypersonic glide bomber.

Calculations based on these reports and other published data indicate that a bomber crew flying above 50,000 ft., where atmospheric absorption of gamma radiation is low, might receive a sufficiently large total dose of radiation from a one-megaton weapon detonated at high altitude 70 mi. away, or from a five-megaton weapon at a range of 150 mi., to prevent completion of the mission. This total dose has been estimated to be 1,000 roentgens. The aluminum skin of the aircraft would provide little protection from hard gamma radiation.

Direct Results

These direct results of high altitude nuclear explosions are not the same as the effects created during the Argus experiments last summer. The Argus tests proved the concept of the trapping charged particles in the earth's magnetic field, to establish shells of radiation surrounding the earth, predicted theoretically by Nicholas Christofilos (AW May 11, p. 63).

A mean lethal dose (that amount of radiation that would result in the death within six months of 50% of the persons exposed) of 450 roentgens would be received by crews at even greater distances but physiological effects of this size dose probably would not be felt in time to interfere with completion of their mission.

Effects to these dosage levels on the aircraft structure, avionic equipment, and nuclear stores at these ranges would be negligible, but at only moderately reduced ranges neutron bombardment would begin to damage radiation-sensitive avionic components such as crystals and semiconductors. At still shorter ranges neutron bombardment of a nuclear store would induce sufficient heating of the store through partial fissioning to destroy it mechanically, although it is doubtful that the weapon could be detonated in this way.

The Department of Defense, however, does not appear to consider this defensive technique as serious a threat as some of its critics. Defense Secretary Neil McElroy told a recent meeting of the Senate Committee on Defense Appropriations that his department has lost no faith in manned bombers and that the need for them remained acute. The department is giving "great weight" to manned bombers as primary retaliatory weapons, he said.

He added, however, that high altitude H-bomb explosions could cause interference with the radars of anti-missile missile systems such as Nike Zeus. He said that the problems might not be insurmountable, but that they were problems just the same.

Partial information on the effects of the two high altitude test explosions was obtained by A. G. McNish of the National Bureau of Standards in analyzing the changes in recordings of the earth's magnetic field resulting from the explosions.

These recordings, or magnetograms, indicate that the explosions which took place at night ionized the upper atmosphere at a distance of 1,500 mi. from ground zero to almost daylight intensity, which resulted in an increase in the electric current that flows through the ionosphere and temporarily altered the geomagnetic field.

McNish speculates that up to a distance of 1,500 mi. from Johnston Island the magnetic field changes are the result of ionization of the very thin upper atmosphere by primary and secondary gamma radiation from the hydrogen bomb explosion. Primary gamma rays are those that travel in a straight line from the explosion, while secondary gamma rays are those that are scattered by the upper atmosphere.

The electric currents that produce the changes in the magnetic field are believed to flow at about the altitude of the E-layer of the ionosphere—that is, at an altitude of about 60 mi. Because the ionization, or breaking up of atoms into positive ions and electrons, is caused by solar radiation, the number of electrons present in the E-layer at night is only about 1,000 per cc., while during the day this number increases to 100,000 per cc.

The changes in the magnetic field measured at a distance of 1,500 mi. for about 30 min. after each of the two explosions indicate that the number of electrons present in the E-layer had increased almost to the daylight level. Recordings taken at 2,400 mi. from Johnston Island showed no distinguishable effect.

The sites where the magnetograms were taken were the regular magnetic observatories operated at Honolulu, Hawaii, by the U. S. Coast and Geodetic Survey, and at Apia, Samoa, by the New Zealand government, as well as three special International Geophysical Year stations on Palmyra Island, Fanning Island, and Jarvis Island. The magnetograms were sent to the National Bureau of Standards because of its specialized interest in ionospheric phenomena and their effects on radio propagation.

Effects Stronger

Because the effects of the first explosion were stronger than those of the second, McNish estimates that the first explosion was at a higher altitude than the second. Using the method of drawing a tangent to the earth's surface that has its origin at the height of the E-layer over one of the observing sites and extending the line so that it only grazes the denser atmosphere (to limit absorption of primary radiation), he calculates the altitude of the second burst to have been between 21 and 30 mi. and the first to have been 12 or more miles higher.

The magnetic field changes measured at Apia do not fit into the electric current system believed responsible for the changes at the other sites. Apia lies just southeast of the geomagnetic conjugate point of Johnston Island in the southern hemisphere, and the changes there are attributed to charged particles from the detonations traveling along the earth's lines of magnetic force and reentering the atmosphere at the conjugate point where they created auroral effects and erratic field fluctuations such as are commonly experienced by stations in the auroral latitudes.

The two high altitude explosions of the Project Hardtack series were launched from Johnston Island, a coral atoll used mainly as an emergency air station, located about 700 mi. southwest of Honolulu, Hawaii. The hydrogen warheads were carried aloft by Redstone missiles. The first explosion was at 12.50 a.m. on Aug. 1, and the second at 12.30 a.m. on Aug. 12.

The first explosion was very clearly visible in Honolulu where the skies

were illuminated by a sudden flash of light that was bright enough to wake some persons from their sleep. The light, radiating from a center in the direction of Johnston Island, is said to have changed color from yellow to orange to red, and was followed by the formation of a cloud that remained visible for about 30 min.

The second explosion was at a lower altitude and appeared as little more than a lightning flash, followed by a dark red or reddish brown glow. This red or reddish brown color probably was due to the generation of various colored compounds such as nitrous acid and oxides of nitrogen by the chemical interaction of nitrogen, oxygen, and water vapor in the air at the high temperatures present at surface of the fireball.

One result of the tests was a sharp interruption in communications following both explosions. After the Aug. 1 tests, outages or blackouts of communications circuits ranged from two hours at Honolulu to nine hours in Australia. After the Aug. 12 test, aircraft in the Pacific area were grounded for as long as 18 hr. by blackouts that extended from Tokyo to California. Incoming aircraft at Honolulu contacted the control tower by means of a line of sight VHF plane-to-plane relay.

These effects resulted from the increased ionization of the upper atmosphere caused by the explosions. The increased ion density can absorb or reflect radio energy, but the problem facing designers of anti-missile missile radars is that explosions at these altitudes could possibly cause the radar signals to be reflected which would blind the radar to incoming missiles above the densely ionized region.

The maximum frequency reflected by such a region is called the cutoff frequency. This frequency can be found by determining the electron density of the region, then multiplying the square root of the electron density in cubic centimeters by the constant 8.97 which yields the cutoff frequency in kilocycles.

Navy Contracts

Washington—Following is a list of unclassified contracts for $25,000 and over as released by U. S. Navy contracting offices:

DEPARTMENT OF THE NAVY, BUREAU OF AERONAUTICS, Washington 25, D. C.

Arrowhead Products Division, Federal-Mogul-Bower Bearing, Inc., Long Beach, Calif., manufacture and furnish eight preproduction models of a lightweight full pressure suit, NOas 59-4152-c(AE-51-4650-59), $38,448.

Photogrammetry, Inc., Silver Spring, Md., conduct research and prepare and furnish an original and two copies of a punch card photographic interpretation key for major industries, NOas 59-6147-c(PH-4-3392-59), $34,975.

Baird-Atomic, Inc., Cambridge, Mass., 225 AQU-1/A bubble sextants in a/w MIL specification MIL-S-21639(Aer.), NOas 59-0268-f(PD-42-2386-59), $1,460,681.

Ampex Corp., Redwood City, Calif., one airborne instrumentation video tape recorder, specification MIL-E-5400, used as a design objective, and one ground video tape recorder/reproducer, Specification MIL-E-4158, used as design objective, NOas 59-4155-f(AV-41-2889-59), $181,500.

Operations Research, Inc., Silver Spring, Md., research and development of spin-top recovery system, NOas 59-6102-f(SI-24-4566-59), $37,654.

Sparton Electronics Division, Sparton Corp., Jackson, Mich., design, develop, fabricate and furnish 200 AN/SSQ-(XN) bathythermograph transmitter sets in a/w specification MIL-S-19763(Aer), and amendment No. 1 with exceptions and MIL-S-19762(Aer) and amendment No. 1 thereto; design, develop and fabricate five CV-/ARR airborne converter units in a/w specification MIL-E-5400B(ASG) with certain exceptions, NOas 59-6130-c(AV-43-2908-59), $117,119.

Shell Development Co., Emeryville, Calif., investigate basic mechanisms in failure of bearings and/or lubricants, NOas 59-6141-c(PR-41-186-59), $56,500.

Chicago Aerial Industries, Inc., Melrose Park, Ill., final report of study of aerial reconnaissance in support of missile warfare, NOas 59-6108-c(PH-4-3390-59), $34,874.

Dayton T. Brown, Inc., Copiague, L. I., N. Y., conduct preproduction lot sample testing for quality control of equipment furnished under BuAer procurement program for armament equipment and provide special tools, test equipment and materials required to conduct tests, NOas 59-0251-c(PD-42-2268-59), $1,047,902.

Research Division, Aeronca Manufacturing Corp., Baltimore, Md., complete ultraviolet miss distance indicator including transmitter, receiver, data handling unit and power supply, NOas 59-4181(PMR)-f(AV-31-2926-59), $38,584.

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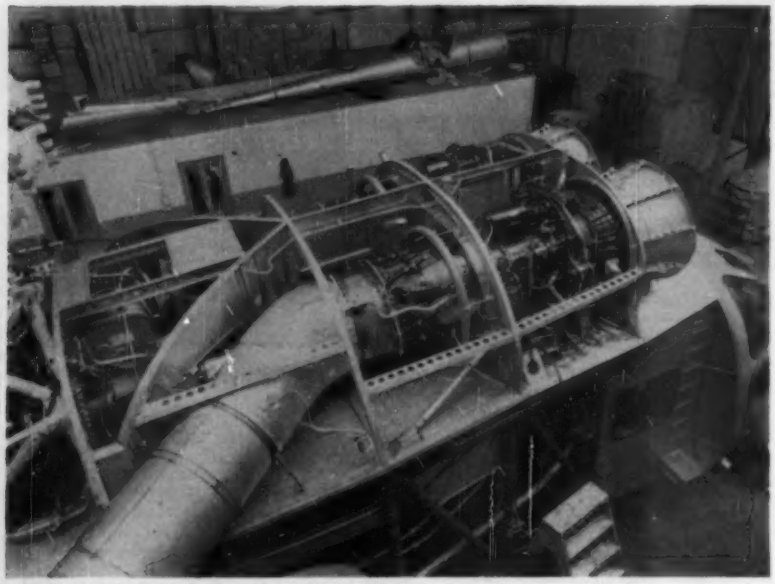
WESTMINSTER, the largest of the Westland line, is based on Sikorsky S-56 rotor system powered by pair of Napier Eland 229 turboshaft engines. Version shown is a prototype of a flying crane; hook-on point is under fuselage one bay aft of main wheel attachments.

Westland Jump to Helicopters Pays Off



NAPIER ELAND 229 rear-drive turboshaft engines are mounted on parallel axes atop the Westminster's fuselage. This installation delivers twice the power of the Pratt & Whitney R2800-50 (1,900 hp. each) piston engines in the Sikorsky S-56 and weighs less.

By David A. Anderton

Yeovil, England—Future of the Westland Westminster, Britain's largest helicopter and biggest private-venture aircraft in years, may soon be brightened by a major policy decision.

Ministry of Supply is expected to order large helicopters for the British military services, primarily as flying cranes. Logical supplier for this task will be Westland Aircraft, Ltd., and the logical aircraft will be Westminster. Only competition to the big helicopter is the Fairey Rotodyne, and it is likely that craft will not be chosen for the military requirement in view of the company's current commitments to civilian customers.

One of four Westland helicopters currently in production, the Westminster attracted much technical attention at last year's Society of British Aircraft Constructors' display at Farnborough. In the hands of W. H. Sear, Westland's chief pilot, the Westminster demonstrated amazing maneuverability for a huge helicopter, and did not suffer by

comparison with the Wessex, Whirlwind and Widgeon, which were also flung around sky with great abandon.

Flying a test vehicle configuration with an open trusswork fuselage, the Westminster had relatively few flight hours behind it then. Since its first flight on June 15, 1958, the flight prototype has continued to roll up flight time and development experience, and will shortly be joined by a second prototype, designed to a flying crane configuration.

Private Funding

So far, the development of the Westminster has been financed completely by Westland, and D. Napier and Sons, Ltd. has contributed the loan of the twin Eland turboshaft engines that power the big craft. Both companies decline to state the amount of their investment, but it is certainly on the order of $3 million total. This is a considerable expression of faith in the British —or any—aircraft industry today, but it rests on a firm foundation of historical precedent and contemporary production of a helicopter line for the military and civilian markets.

The historical precedent is that Westland has developed four helicopters during the past decade, all of them initially as private ventures and three of them financed completely through first flights and early development without one penny of British government support. Production versions of these aircraft were built in advance of orders, on little more than faith and the company's resources. The helicopter sold, and each variant provided, through the production run, a firm financial base for the development of the next line.

Westland's development work has received a mighty assist from a series of cross-licensing agreements with the Sikorsky Division of United Aircraft Corp. All of the Westland craft so far have been based on the Sikorsky rotor system, using it intact in the design, plus an adaption of the basic Sikorsky conception to the specialized purpose of the design. In some cases this meant simple rework of the fuselage to take a British engine. In others it meant partial redesign to provide a weapons bay, for example. In the Westminster it meant using only the main rotor system, the tail rotor and controls, and designing a completely new fuselage.

Westland Line

Currently this is the Westland line:

• **Westminster,** a 36,000-lb. helicopter using the five-blade main rotor and head, the tail rotor, drive shaft and pylon of the Sikorsky S-56. Powerplant is a pair of Napier Eland 229 rear-drive turboshaft engines mounted on the cabin top. Engines are one-off units, and deliver about 2,800 shp. each, less

WHIRLWIND nose has been modified to house single GE T58 turboshaft engine.

WESTLAND WESSEX is basically a re-engined Sikorsky S-58 powered by a Napier Gazelle.

WIDGEON five-place helicopter is evolved from Dragonfly, an adaptation of Sikorsky S-51.

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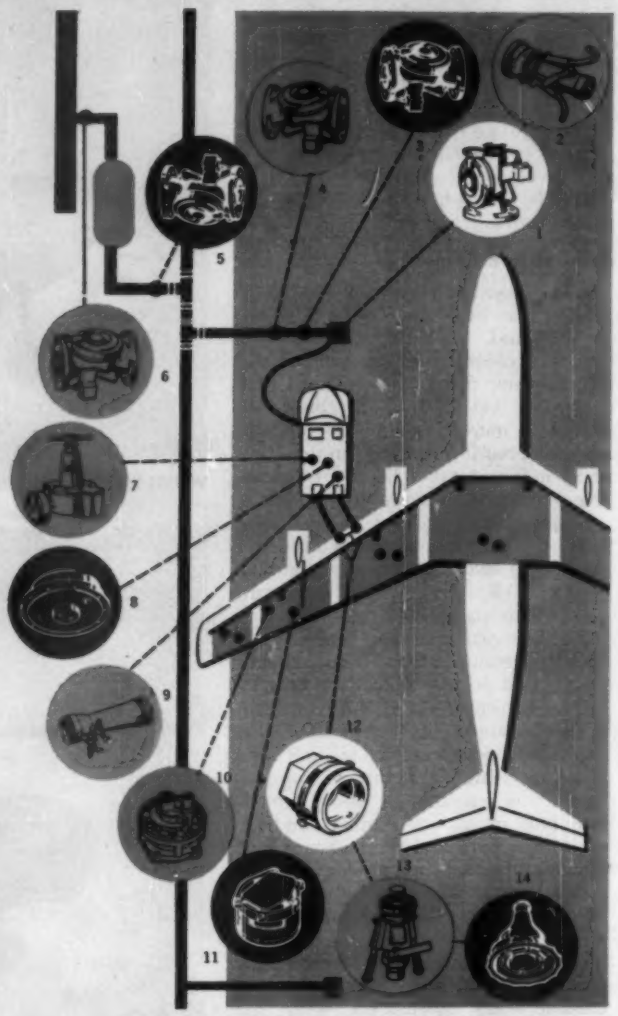

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than the eventual 3,500 shp. rating of the Elands intended for production models. Planned in two versions, the Westminster should be able to handle 40-46 passengers in the transport version, and a wide variety of payloads, depending on desired range, in the crane configuration.

• **Wessex,** for Royal Navy anti-submarine work, but also designed to the British airworthiness requirements for future civil sales. The helicopter is basically a Sikorsky S-58 which has had its original Wright Cyclone engine replaced by a Napier Gazelle 13, delivering 1,450 shp. This is less than the Cyclone power, but the Wessex has better performance than the S-58 due to the lighter engine installation and the absence of power loss due to the cooling fan and clutch of the S-58. Civil capacity is 12 passengers, baggage and a crew of two. Military capacity is 5,000 lb., but present cabin capacity is not for more than 14 fully equipped troops.

• **Whirlwind** built in both civilian and military versions. This helicopter is the Sikorsky S-55, re-engined with the Alvis Leonides Major derated to 750 hp. In its naval configuration (Whirlwind HAS.7) it works in pairs in the anti-submarine role as a hunter-killer team. One Whirlwind carries American sonar gear, and the other carries a homing torpedo. Passenger version carries eight people, or a ton of freight can be handled over usual ranges.

• **Widgeon,** the oldest of the basic Westland line. This little five-seater started life as the Dragonfly, which was the Sikorsky S-51 re-engined with the Alvis Leonides delivering 515 hp. Forward cabin section was redesigned and enlarged, and a Whirlwind (S-55) rotor system replaced the original S-51 head. The Dragonfly, through metamorphosis, had become the Widgeon.

After Westminster

The company has a big task ahead in developing the Westminster through its two parallel configurations. The trusswork geometry of the first prototype was chosen for convenience: "Easiest airframe to analyze that we ever built," said D. L. Hollis Williams, Westland technical director.

This first prototype has been irreverently dubbed "The Bridge on the River Kwai," or "the flying cutaway drawing," and even Westland engineers have said that the big ship was simply an ordinary helicopter drawn on much bigger pieces of paper.

This does not conceal a real respect for the product and pride in the achievement.

The other delight in the Westland engineering department is the projected passenger version of the Westminster, now sitting in one corner of the experimental shop in mockup form, resplend-

NEW HAMPSHIRE BEARING ABSTRACTS

by A. N. DANIELS, *President*
New Hampshire Ball Bearings, Inc.

NEW TECHNIQUES SOLVE SHIELDING AND IDENTIFICATION PROBLEMS

For some time, now, the precision instrument bearing industry has been searching for the solutions to two problems: (1) *how to develop a more effective shield;* (2) *how to provide visual identification for parts as small and precise as instrument bearings.* Exhaustive research in both areas has finally borne fruit for New Hampshire Ball Bearings, Inc. Both problems have been solved. The solutions seem so simple that it's surprising they weren't discovered long ago.

MORE EFFECTIVE SHIELD

What a big difference a slight change from traditional design can make! By eliminating the recess in the inner ring, New Hampshire's design engineers have reduced by more than 70% the size of the dirt particles that can get into the bearings.

The primary function of a shield is to keep dirt out of the bearing. A contact seal between the two rings wouldn't do. It would increase torque and cause wear. The rings must be able to turn independently. So, the idea is to close the gap as nearly as practicable.

Fig. 1

Fig. 2

The conventional answer, (Fig. 1), inherited from large bearings, falls down badly. Because the recess has to be machined instead of accurately ground, the gap between shield and recessed surface is as high as .007", while that between shield and shoulder is even higher. This means that dirt particles as large as .007" can get in. With large bearings this is not too serious a problem. But with some of the small bearings, such particles are ¼ as large as the ball. That creates a serious torque and wear problem.

Defenders of the old design argue that the recess creates a "labyrinth" effect that discourages entry of large particles. New Hampshire designers maintain, however, that a smaller gap is the more effective answer.

New Hampshire's design, *(Fig. 2),* closes the gap to .002" or less than ⅛ that of the old design. This close tolerance is made possible by fitting the shield to the precision ground O.D. of the inner rings. This simplified design has no corner where dirt and dust can collect to cause drag between shield and ring. It also provides a broader reference surface for the mounting.

VISUAL IDENTIFICATION

A new marking system, recently introduced by New Hampshire Ball Bearings, Inc. gives you three important pieces of information at a glance. When you see the marks, you know that the instrument bearings are made by New Hampshire . . . that you are getting ABEC 7 tolerances or better at no extra cost . . . whether they're made of stainless steel or chrome steel.

Here's the code. Sets of double lines 120° apart indicate Stainless Steel, *(Fig. 3)* . . . 180° apart, Chrome Steel, *(Fig. 4).* Such visual identification assures correct deliveries by New Hampshire, correct application by you.

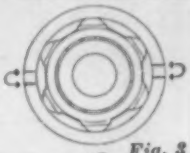

Fig. 3

Fig. 4

Notice that the marks are applied to one face of the outer ring where research proves there can be no detrimental effect on performance, mounting characteristics or bearing life. Marks are applied by impact before grinding and heat treating. They cause no dimensional change, distortion or destructive effect on finish.

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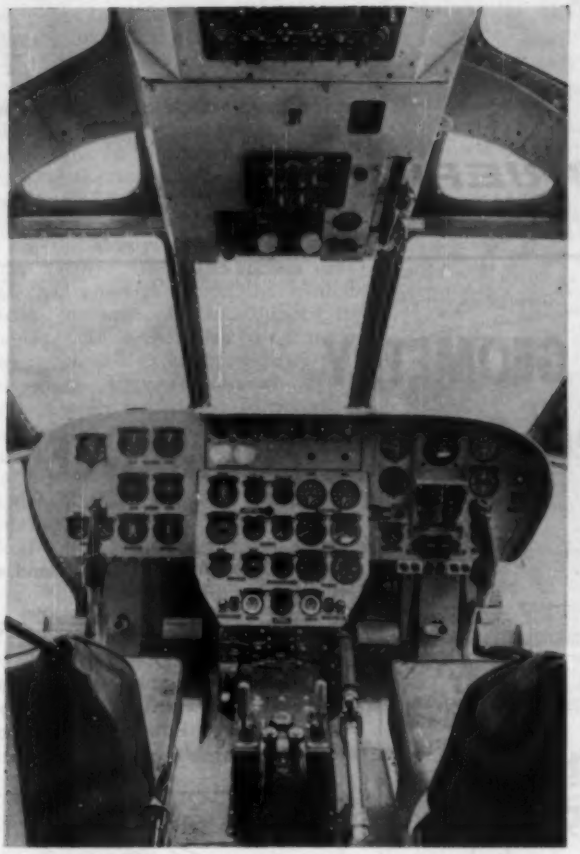
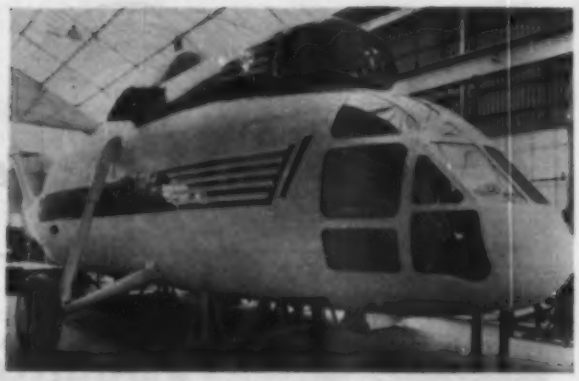




TRANSPORT MOCKUP of the Westminster (above) shows configuration of this version of the helicopter. Five-abreast seating layout is shown below. Capacity will be 40-46 passengers.

PILOTS' POSITIONS for Westminster transport are shown in mockup. Layout is exceptionally clean, and instruments are easy to locate and monitor. The pilots have excellent visibility forward, to the sides, and downward.

ent in a blue and white paint job. This mockup, well-built and beautifully finished, gives a technical observer a strong impression of the future transport.

This job and the flying crane Westminster will account for a large portion of the company's efforts during the next few years. But its engineering department will have the job of breaking new ground and starting new projects.

"We think the market will follow the twin-engined helicopter," Williams said. This may indicate that one future project could be re-engining the Wessex, along the lines of the U. S. Navy HSS-2 which uses a pair of General Electric T58 turboshaft engines. These engines are being built under license by de Havilland in Britain as the Gnome.

Turbine Tests

A modified Westland Whirlwind is now flying with a single T58 installed by Westland. The modified ship made its first flight Feb. 28 with Sear at the controls. The T58 drives a standard Whirlwind rotor through a special de Havilland angled gearbox. The first flight lasted one hour, covered a full range of tests including relighting, prolonged climb and quick stop.

When the T58 trials are completed, Westland will replace the engine with a de Havilland Gnome for comparative tests with the British engine.

A parallel installation of the Armstrong-Siddeley P.181 turboshaft engine is also in the works at Westland. Both engines, together with two other British developments in the same class, were described in AVIATION WEEK (Oct. 20, p. 66).

Westland's entry into the helicopter field was a difficult decision. The company found itself at war's end with a very successful record as a big producer of other companies' designs, and some experience with its own famous types. It had a contract in hand for the development of a naval strike fighter, but Westland was looking beyond that.

The handwriting was on the wall at many a British aircraft factory at that time, plainly to be read by the more progressive managers. It was obvious that airplanes and weapon systems were getting larger and more complex. Westland, with experience in some fairly complicated types of military aircraft, probably realized more clearly than some other firms the extent of capitalization in plant, research facilities and investment that would be needed for future military development.

Westland also saw it would be out of the running in competing commercially in the fixed-wing transport field with the giants of the British aircraft industry. Furthermore, it did not want to fall into one of the many postwar aeronautical traps, such as tiny transports to replace DC-3s, that had been set by imperfect analyses of what was really needed.

Important Decision

Westland management had convictions and the courage of its convictions, and made a hard decision. It decided to drop everything else and concentrate on the rotary-wing market.

In 1946 Westland concluded its first license agreement with Sikorsky for the S-51 ". . . in order to gain entry with a recognized type and to buy time and experience," explains E. C. Wheeldon, now Westland's managing director but then works director. The engineers started adapting the American airframe to the British Leonides engine. Over in a corner some of them began thinking in terms of future helicopter design.

Since then, the company has made

One in a series of technical reports by Bower

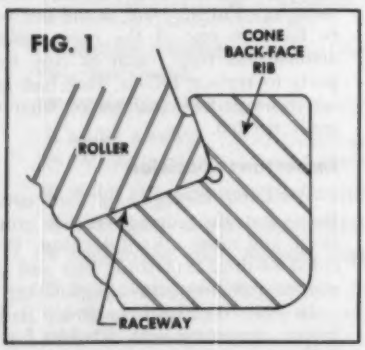
BEARING BRIEFINGS

BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

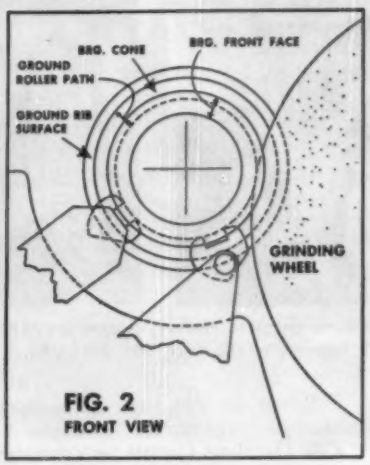
Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under



load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

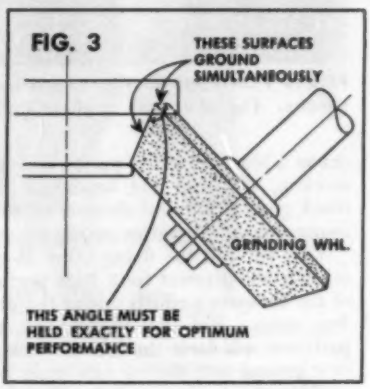
In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower



bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and side views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.



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When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

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four separate license agreements with Sikorsky, following the S-51 with the S-55, S-58 and S-56. Each one of these developments was initiated entirely by Westland as a private venture. Orders followed, in the cases of the first three, but the risk had to be taken by Westland and the initial high costs of development had to be borne by the company and its stockholders.

For the Wessex program, the company bought a complete S-58, and after Sear had checked out in the United States, the helicopter was shipped to England and re-assembled to get more experience and to calibrate basic performance. After considerable flying time, happily marked by receipt of a Royal Navy production commitment, the Wright Cyclone was removed and the S-58 was re-engined with an early model Napier Gazelle. About eight months after the conversion began, the Wessex flew.

"We saved about a year on that one," says Hollis Williams, "and we wound up with a better performer."

One interesting point is that each successive Westland development has used a little less of the basic Sikorsky design, and the Westland engineers have gotten a little further away from American influence and toward their own concepts. The Westminster, as the current "latest" type, is the biggest step so far, and involved much more than re-engining.

Happy Association

The company is happy with its association with Sikorsky, and proud to have been able to make the agreements two-way streets for the exchange of engineering information. For example, Westland has had a large amount of gas turbine drive experience on Sikorsky types that was given to the American firm, particularly that on the big S-56 rotor system. The twin Eland installation for the Westminster, and its gearbox design, was a real pioneering job in the installation of large gas turbines in a helicopter. Control systems, regulators, all the myriad plumbing and wiring was new and ground-breaking.

What resulted was a twin-turbine powerplant that weighed much less than the installation of the Pratt & Whitney R2800-50 piston engine in the Sikorsky S-56, but delivered about twice the horsepower.

This experience was also made available to Sikorsky.

In addition to building helicopters, Westland operates a rotary-wing flying school at one end of the company's grassy landing field here. Military and civilian pilots have converted to the three types of Westland helicopters, and the school continues to turn out pilots.

Within weeks Westland will open

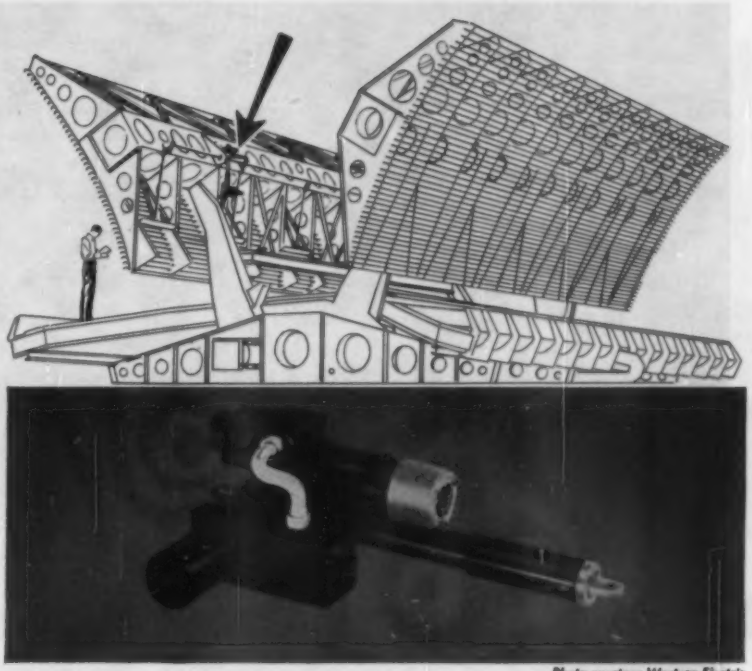

Photo courtesy Western Electric

R2552 LINEATOR exemplifies Airborne capabilities in large special actuators. Installed in pairs, units control tilt and shape of DEW Line antenna reflectors, must operate in temperatures from —65 to +130°F.

Airborne large special actuators used for DEW Line antenna control

Airborne large special actuators are being employed today in a diversity of applications, both air and ground. On the DEW Line, for example, pairs of Airborne R2552 LINEATOR actuators are used to control the tilt and shape of AN/FPS-19 antenna reflectors. Environment in this instance involves extreme temperature and humidity conditions and these call for a high order of mechanical and electrical reliability.

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Aeronca is proud that its capabilities have been selected to support the North American B-70 and F-108 Weapons Systems.

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another privately funded operation: a heliport on the Thames at Battersea, a London suburb. Some months ago, forecasting the need for such a landing station and seeing in its own products prospective users of such a station, Westland applied for and received permission from the Minister of Housing to build the landing site.

Permission included the right to operate the site for a period of seven years. The heliport will, of course, be open to all comers. It is designed to handle the landing loads of a Westminster-class helicopter, and will be able to park and load six of the biggest of the current crop of helicopters. There will be the usual buildings for passengers and traffic control, plus an auto parking lot.

Landing site is a conventional T-shaped layout, extending out into the Thames about 100 ft. At low tide most of the port will be over the muddy shore, and at high tide there will be negligible interference with the usual high volume of Thames riverboat traffic.

Heliport Traffic

Traffic forecasts, admittedly imperfect, indicate that later this year weekly traffic movements should be about 20 helicopters carrying on the order of 100 passengers total. This figure should be increased if, for example, there is a special shuttle service at Farnborough time this fall.

There are still two more projects in the Westland group. Normalair, Ltd., one of Britain's prime producers of oxygen and cabin climatization equipment, is a wholly owned subsidiary of the company. After a long period when returns on the investment were low, Normalair got into production runs and started to return a profit to the group.

But recent White Papers, stopping the further development of manned aircraft—which in the event proved to be a premature halt—seemed to cast gloom on the Normalair future. No manned aircraft, no man to breathe oxygen through its equipment. The company has turned its versatile engineering staff to other problems in the handling of moving gas flows, has current contracts for equipment or complete systems on most British aircraft and many foreign aircraft, and seems to be well off as to future position.

The other Westland subsidiary is Westland Engineering, Ltd., a group designing and producing specially designed doors for industrial buildings. This unit has continued to expand during the past year and is making production deliveries of a small, but financially substantial, number of door installations.

Westland was a war baby, born in 1915 and named after a farm on which its parent's factory—Petters, Ltd., manufacturers of Diesel engines—estab-

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WHIRLWIND MK. 7 is in production for the Royal Navy as a submarine killer. Flight photo shows the weapons bay in the belly, designed to carry a homing torpedo.

lished an aircraft construction works. Petters had decided to place its firm at the disposal of the government for the war need of Britain and within a matter of days had received its first contract to assemble a dozen seaplanes.

The inevitable happened. The next airplane Westland was asked to build hadn't been completely designed in detail, and Westland started an engineering department to do the work. This group eased into original design and developed the first all-Westland plane, a single-seat biplane seaplane with a full-span flap.

The company's first experience with American aircraft engineering came during their subcontract work on the British de Havilland DH.9. Orders for the original design were curtailed in favor of production of the more-powerful DH.9A, the same basic airframe powered by the American-designed Liberty engine. Westland was assigned the responsibility for its installation, and built about 400 of the planes before the war ended.

Pioneering Designs

During the years between the end of the first World War and the end of the second, Westland built about one of everything and two of some: military and civil, fighters and bombers, transports and sports planes, a tailless airplane and several rotary-wing types. Many of these were pioneering designs and many served the Royal Air Force or the Royal Navy long and well.

Best remembered of the wartime types is the Lysander, an ungainly high-wing monoplane with fixed, big-panted landing gear. Lysanders were officially developed for Army cooperation, which eventually took as many forms as the cooperators could think of. The Lysander dropped and picked up agents in occupied countries, delivered beer to thirsty troops, bombed and strafed ground targets, shot down bombers, did air-sea rescue work and towed targets.

Wartime subcontracting centered on the Spitfire and its naval variation the Seafire, about 2,000 were built by the company. Parallel to this production work, engineering development was directed toward the first pressurized high-altitude fighter, visualized in a 1940 specification as a 40,000-ft. airplane armed with cannon.

The Westland Welkin was the final form of this specification, and it initiated the company into the mysteries of pressure cabins at a time when such experience was rare, if not non-existent. One outgrowth of this experience was Normalair, Ltd.

Last of the fixed-wing airplanes to be developed at Westland was the Wyvern, a single-seater strike aircraft for the Royal Navy, and one which in the early 1950s, thrilled the crowds at Farnborough by low-altitude aerobatics while carrying a full load of externally slung torpedoes and rockets. Its distinctive angry-wasp sound and the abandon with which Harald Penrose, then Westland's chief pilot and now sales manager, flung the plane around the sky left an indelible impression on the observers of the big British air event.

Financially Westland is doing well. It continues to pay dividends on the order of 6% to stockholders, while at the same time writing off the high development costs of its private ventures and ploughing money back into modernization of plant or project development or any of a half-dozen possible sources of future growth.

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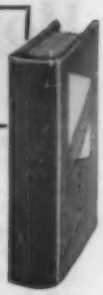

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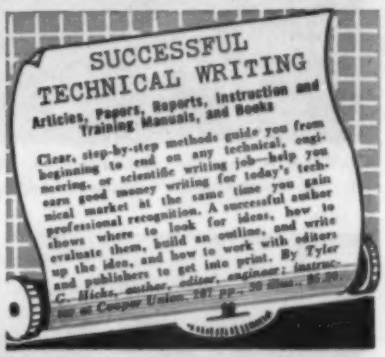

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Honeycomb Plays Big Role in B-70, F-108

By William S. Reed

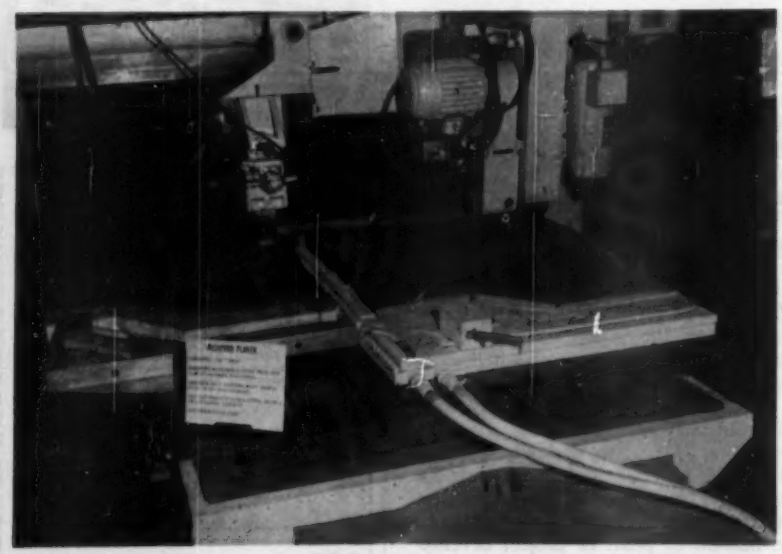
Los Angeles—Rigorous design requirements of North American Aviation's Mach 3 B-70 bomber and F-108 interceptor call for a more extensive use of metal honeycomb sandwich structure than previously applied to any aircraft. Application of metal honeycomb sandwich in constructing these two aircraft is toughest test yet of this new type structure.

B-70 Valkyrie will use approximately 20,000 sq. ft. of stainless steel honeycomb sandwich, while the F-108 interceptor will use about 3,500 sq. ft. Most extensive use of metal honeycomb sandwich yet in any operational aircraft is in Convair's B-58 Hustler, employing approximately 850 sq. ft. of the structure.

Whether the B-70 and F-108 meet design and operational goals depends directly on North American's ability to develop production methods of stainless steel honeycomb sandwich in quantities, sizes, and shapes required for these two top-performance aircraft. Company does not plan major production effort but will make data available to potential subcontractors.

As late as December, 1957, the largest metal honeycomb sandwich panel produced measured 4 ft. by 6 ft. North American now is able to produce a stainless steel honeycomb sandwich by brazing the core to skin for panels as large as 10 ft. by 20 ft. Configurations include flat panels, double contour sections, semi-circular intake scoops and curved speed brakes.

ULTRASONIC machine is used to inspect and test brazed stainless steel honeycomb panels at $\frac{1}{10}$nd in. intervals. Vibrations are impinged through a stylus.



ABRASIVE belt grinding method permits core thickness accuracy to within .001 in. After this operation, parts are acid-bathed and then kept in a dust-free room.

Project Teams

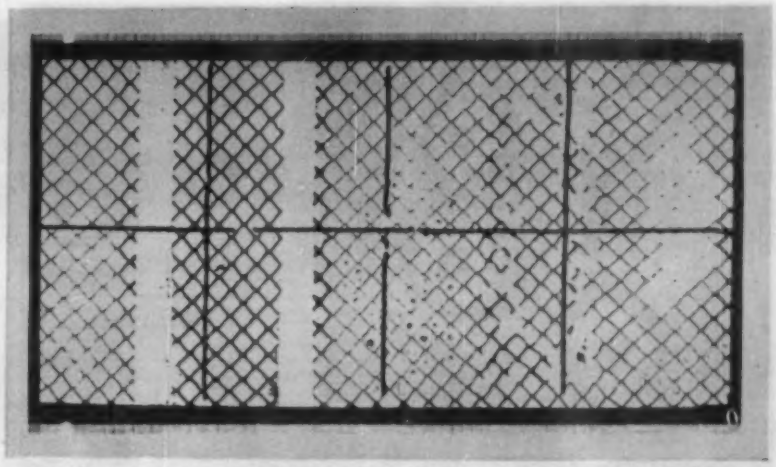
The company's success is a direct result of a basic effort started in early 1958 which involved setting up project teams to develop new fabrication methods to produce flyable hardware by late 1959. Production engineering details now have been worked out to where North American is confident it can meet design requirements.

Decision regarding the extensive use of stainless steel honeycomb was dictated by mission requirements involving Mach 3 cruise and attendant high thermal and aerodynamic stress, plus the great payload and fuel capacity to accomplish a long mission profile.

North American chose stainless steel honeycomb sandwich because it offers multiple advantages of light weight, extreme rigidity, low strength decay with high temperature, and exceptional surface smoothness and hardness. Smooth panels are free from "oil canning" and other irregularities associated with conventional construction methods. In appearance, surface smoothness resembles finished plastic, and surface is extremely hard, resistant to dents and gouges. According to North American engineers, sandwich panels are so tough that they were hard put to damage them so that methods of repair could be investigated.

After experimentation with several methods of manufacture, including resistance welding, the engineers decided on a brazing technique. Material used for face panels and core is precipitation hardened 15-7 Molybdenum Corrosion-Resistant Stainless Steel (PH 15-7 MO CRESS). A sterling silver-lithium alloy foil is used for the brazing flux. PH 15-7 MO CRESS was chosen because it falls within the design range for the B-70 and F-108—compressive yield/density ratio of 60 to 90 (times 10^{-4} in.) at temperatures ranging from 450 to 640F.

A characteristic finished panel, ac-



HONEYCOMB sandwich test panel (left) measures 12 x 14 ft. Surface was marked to facilitate X-ray inspection. At right, facsimile recording from ultrasonic tester shows where brazing was not complete; light spots at right show where core failed to mate with skin.

cording to North American, has a tensile strength of 242,000 psi. and yield strength of 227,000 psi. Obtaining stainless steel honeycomb core in quantity has proved a problem, according to engineers, and they now draw from seven core manufacturers to fill their needs.

Steps Taken

Stainless steel honeycomb sandwich also is adaptable for construction of integral fuel cell use, offers the bonus of insulating the fuel from aerodynamic heating. Steps had to be taken, however, to prevent the silver alloy brazing foil from "walking" along the core and making a silver-to-silver connection with braze metal at opposite edge of core. Thus, the silver, an excellent conductor of heat, would bring external heat into the sandwich to defeat the insulating property of the panel.

The solution, North American found, is to "poison" the silver foil with an additive to reduce its "flowability," so that original braze fillet shape is retained.

Production Detail

Here's how company production engineers prepare stainless steel honeycomb sandwich panels:

• **Face sheets and core** are cut to outline, including cutouts, openings for inserts, and accommodations for channel edge members. In some sections, thickness of the face sheets and core varies. Core material is reduced to the required thickness by use of a belt sander, with an accuracy of plus or minus .001 in. Method of shearing face sheets has been developed by North American which eliminates any "curl over" which normally would be formed by a cutting process.

• **Parts are acid-bathed** several times for complete cleanliness and thereafter are kept in a dust-free room. All handling is with white cotton gloves to preclude contamination by dirt or corrosive perspiration.

• **Sandwich is assembled** with silver lithium alloy foil brazing sheets between core and face sheets. Assembly, together with attachments and channel members, is tack-brazed to ensure maintaining relative position of the various components.

• **Assembled sandwich panel** is placed in a retort, dimensions and size of which are dictated by configuration of the panel. Where necessary, a blanket or core material is used between sandwich and retort inner surface to prevent warping during the heat-treat operation.

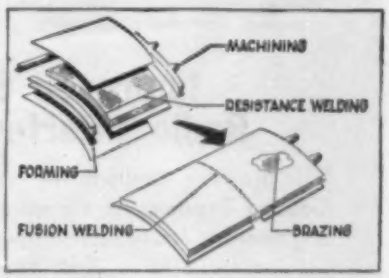
• **Retort is welded completely** around its perimeter, making it airtight. Purge tube is included for evacuation.

• **Copper overlay** is then put around the retort to enclose it completely, ensure uniform heat distribution throughout heat-treat phase. Copper must not contain impurities since this will cause warping in the copper, resulting in improper heat distribution in retort, in turn causing sandwich to warp or blister.

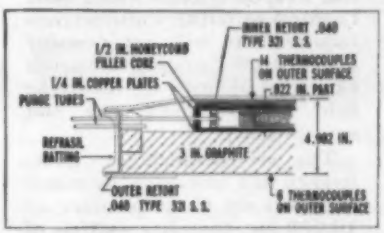
• **Air is evacuated** from the retort and argon gas is introduced. This inert atmosphere is maintained throughout the heat-treat cycle.

• **Heat source varies** according to size and shape of panel involved. For large flat panels, the gas-fired porous brick furnace is used. The method involves placing retort and copper plates inside another larger retort which contains a solid graphite bed, used as a support (flat or curved) to maintain shape of inner retort during brazing operation. Graphite is used because of its low thermal expansion and adaptability to wood-shaping methods for obtaining various contours.

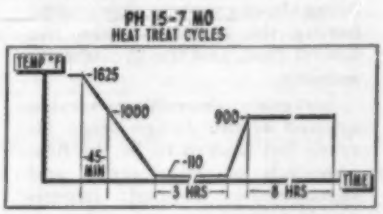
Salt bath quench method also may be used. In this method, the retort is placed in molten salt bath maintained at 1,625F. The retort is then removed and placed in hydraulic press which is brought in to light surface contact with the retort. Press acts as a heat sink to cool down retort. The method is limited to smaller panels because of small size of the salt bath furnace now



DRAWING illustrates steps in producing stainless steel honeycomb sandwich panels, with exception of silver brazing foil insert.



COMPLEXITY of honeycomb brazing is evident in this double retort setup (above). Panel heat-treat cycles are shown below.



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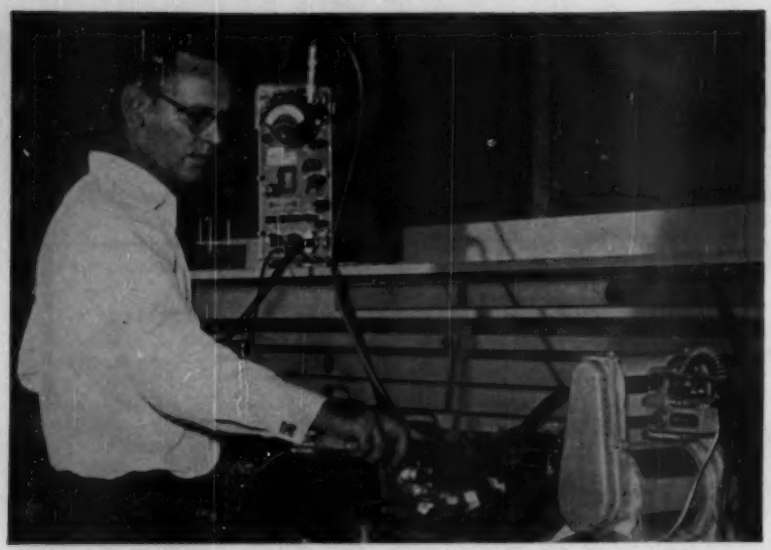

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Sprague Interference Control Laboratories are located on the Pacific Coast, in the Mid-West, and on the East Coast. These laboratories are staffed by top interference and susceptibility control specialists, and are equipped with the most advanced instrumentation and model shop facilities.

For further information, write to Interference Control Field Service Manager, Sprague Electric Co. at 12870 Panama Street, Los Angeles 66, California; 224 Leo Street, Dayton 4, Ohio; or 327 Marshall Street, North Adams, Massachusetts.

operated by North American. The electric blanket is a third method. Procedure can be almost entirely automatic because electrical heat input can be preselected through a timer arrangement and brazing temperatures carefully controlled by the use of thermocouples.

After a controlled cool-down, the units are reduced to −110F for three hours, then brought back to 900F and held for eight hours. Following the heat-treat, sandwich panels are removed from retorts. Graphite beds, retorts and copper panels are constructed so that they may be reused. Retorts, which are cut open, are built with excess edge material and may be used as many as six times.

The panel is then immersed in water and subjected to ultrasonic testing. Vibrations, through a stylus, are impinged on both interior and exterior surfaces at $\frac{1}{32}$-in. spacing. A facsimile recorder makes an accurate scale picture of the core to the surface braze pattern. If the braze is successful, no unusual oscillation pattern is picked up by the stylus. At points where the braze did not "take," a blank space appears on the facsimile, giving a true picture of braze imperfections.

X-Ray Inspection

X-ray inspection methods also were tried by North American, may still be used in certain specialized cases. This method, however, proved costly and time consuming—requiring one hour per sq. ft. and costing approximately $16 per sq. ft. Ultrasonic testing, although not completely developed, promises to be much faster and less expensive than X-ray methods. With more experience, the company believes it can increase the ultrasonic testing interval to $\frac{1}{4}$ in., thereby doubling inspection speed. A double stylus would boost speed of inspection even more. Both X-ray and ultrasonic testing have shown a 99% success in the brazing operation.

Although North American has made a firm decision to proceed with the brazing technique for honeycomb sandwich fabrication, engineers admit that a resistance welding technique would probably produce a lighter structure. No one has successfully produced a resistance-welded structure that begins to approach the strength of brazed sections in large panels, the engineers claim.

Fabrication by brazing structural panel completely changes the appearance of the production line. Instead of the conventional array of jigs, fixtures, and bits-and-pieces of structural components, the brazing area more nearly resembles a foundry with its large furnaces, retorts, graphite beds and heated environment.

LEFT CONSOLE of Chance Vought F8U-1P Crusader jet fighter contains the control panel for the Lear automatic flight control system; unit has variable handling qualities and now is undergoing flight testing.

Lear Control Unit Has 'Built-In' Variables

Los Angeles—An automatic flight control system with variable handling qualities has been built and installed by Lear, Inc., in a Chance Vought F8U-1P Crusader. Contract is between Navy and Chance Vought Aircraft, Inc., with Lear as subcontractor.

Evaluation of automatic flight control systems for high performance aircraft has always been a difficult process. The problem is that evaluation is based primarily on pilot opinion regarding "feel."

Firm Specification

Efforts to optimize aircraft handling qualities necessitate generation of a firm specification, since through control stick steering, high performance aircraft flying qualities can be "tailor-made" to pilot requests.

As many variables as possible have been built into the Lear flight control system. No effort has been made, according to the company, to produce those qualities in an autopilot which it considers optimum. Rather, the entire system is designed so that various modes of operation can be selected in flight and compared. A series of evaluation flights by several pilots, during which all modes of operation are used, is projected to result in establishing more definite specifications.

Past experience with autopilot evaluation flights has sometimes led to condemnatory reports as to autopilot or automatic flight control system performance. In a few cases, unfavorable reports have been justified, but in many cases fault was not a result of poor design.

Review of the specification often showed a lack of perspicacity in the wording of the requirements, resulting in equipment which met the specification but did not fill the requirement.

Both Navy and Lear hope that enough data can be obtained from the variable handling qualities F8U to provide a firm foundation for writing specifications in the future.

Lear's installation uses control stick steering, whereby pilot inputs are sensed by a force transducer located on the control stick. Inputs are transmitted to the autopilot which schedules displacement of the ailerons and stabilator through servos as in other control stick steering methods.

Roll Axis

The difference in Lear system, however, comes in the introduction of variables into the roll and pitch modes. The roll axis of the aircraft has four modes permitting the pilot to select such options as roll rate stability augmentation, attitude hold, precision attitude command or a combination of these. In three of the models, attitude is maintained automatically when stick force is released, but is disconnected with application of 1.5 lb. force on the stick.

Pitch axis control can be varied by switching to any one of six different modes which include pitch control through rate augmentation or normal acceleration, pitch attitude control, attitude command by means of stick force

Temco AIRCRAFT DALLAS

NAVAL AVIATION MAKES HISTORY

with ALL-JET TRAINING

NAVCAD Earland R. Clark of Stroudsburg, Pa., receiving congratulations from Rear Admiral Joseph M. Carson, Chief of Naval Air Basic Training.

On March 13 at the Naval Air Basic Training Center, Saufley Field, Pensacola, Florida, the first student pilot in Naval Aviation history soloed a primary jet aircraft — without previous propeller-driven aircraft experience. The flight was made in a TT-1 "Pinto" — designed specifically by Temco for all-jet training.

The first primary jet trainer ever purchased by any of the U. S. military services, the Pinto is designed for today's jet age. It is built closely along the lines of high-performance jet fighter aircraft and gives the student pilot the "feel" of jet training from the very beginning.

With its high safety standards, fine handling characteristics, optimum maintenance provisions and overall reliability, the Pinto is an ideal primary jet trainer. From initial cost to operation and maintenance, it is designed to provide better pilots at less cost, in less time. All in all, it gives the Navy a decided edge in the ever-advancing pace of military jet aviation.

TEMCO

ELECTRONICS • AIRCRAFT • MISSILES

SYSTEMS MANAGEMENT	DEVELOPMENT
DIRECTED RESEARCH	PRODUCTION

of less than 6 lb., or combinations of the above.

Lear's automatic flight control system also provides four different types of directional control. Manual heading hold in which aircraft will maintain heading existing at the time heading hold is engaged, automatic heading engage which keeps the aircraft on the heading existing when time bank angle is less than six degrees, heading command for making small heading corrections when bank angles do not exceed six degrees, and heading select in which aircraft will turn to a preselected heading put into the ID 250.

Pitch Trim

At the pilot's option, pitch trim will operate with servos either in series or parallel. In series operation, the control stick will not move when the autopilot is trimming the stabilator to hold desired attitude or speed. In the parallel system, stabilator trim corrections made by the autopilot are fed back to the control stick. An example of what this means to the pilot is evident when considering an aircraft making transition from subsonic to supersonic flight. As the aircraft approaches Mach 1, formation of shock waves causes the center of pressure on wing to move aft, producing a nose down moment. The automatic flight control system senses this nose-down pitching moment and trims the stabilator to correct for it. With servos operating in parallel, the pilot would be aware of stabilator trim change through stick movement, but in series servo operation he would be unaware of stabilator trim change.

Speed Stability

Another problem which is being investigated with the automatic flight control system is that of speed stability. Most aircraft have positive speed stability subsonically; that is, the aircraft tends to climb as speed is increased and to dive as speed is decreased.

In most cases, however, speed stability becomes negative when the aircraft is flying supersonic. The system will provide speed stability either through an "open-loop" or "closed-loop" system. The open loop system schedules stabilizer trim against Mach number. The closed loop system holds Mach number with stabilizer trim.

At all times, trim is automatic. Mach hold and altitude hold can be engaged at any time. Should the automatic flight control system malfunction, aircraft normal hydraulic control system still functions.

Other safety features include two levels of g limiter. With less than 1.5 lb. force applied to the stick, the limit is approximately 2.5g. With greater force applied, the limit is 4g. Also included is an aileron deflection limiter which controls aileron deflection to limit roll rate.

The degree of aileron deflection is controlled as a function of "q" or indicated airspeed.

The automatic flight control system control panel is located on the left console behind the throttle, but to enable the pilot to determine which mode of operation he has selected, a panel containing 25 lights arranged in five rows is placed on the instrument panel just below the glare shield.

The panel is an approach to the morphological or "building-block" method of arriving at the solution of a complicated problem.

Autopilot behavior is also variable through any of 27 potentiometers which change gain of the different functions. Gain settings on all 27 potentiometers were made in the first two functional evaluation flights flown by Lear test pilot Ken Kreamer.

Total funds provided by Navy for this contract amounted to $130,000 which included design, construction and installation of autopilot in the F8U, plus company, Navy flight evaluations.

TEST PANEL (A) allows "building-block" approach to determining best modes of operation. Box (B) contains potentiometers to vary gain settings. Force transducer (C) is on stick.

Servoed Gunsight Cuts Size of Sight Head

General Electric Co.'s Light Military Electronics Department, Utica, N. Y., has developed a servoed version of its K-19 lead-computing aircraft gunsight.

Separation of the optics from the gyro elements in the servoed unit makes possible a smaller sight head.

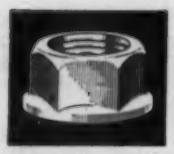
Sight will go on advanced versions of the Republic F-105 and possibly on the Lockheed F-104, now using the older K-19 sight.

New from SPS Laboratories

FN-12 Featherweight Locknut

NAS 679 replacement offers weight savings up to 60%

. . . available immediately in sizes #4 through 1 in.



This new forged featherweight locknut replaces widely used NAS 679 sheet metal nuts* and weighs 12-60% less. Price is practically the same or, in some sizes, lower. New configuration permits installation closer to vertical bulkheads, allowing additional weight savings through use of narrower flanges. Offers 160,000 psi tensile strength on 180,000 psi bolt. Available immediately in 11 sizes—#4 through 1 in. For new Bulletin 2426, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium.

*Also interchangeable with MS 20364, MS 20365; NAS 1021, NAS 1022; AN 363, AN 364, AN 365 and AN Plain Nuts

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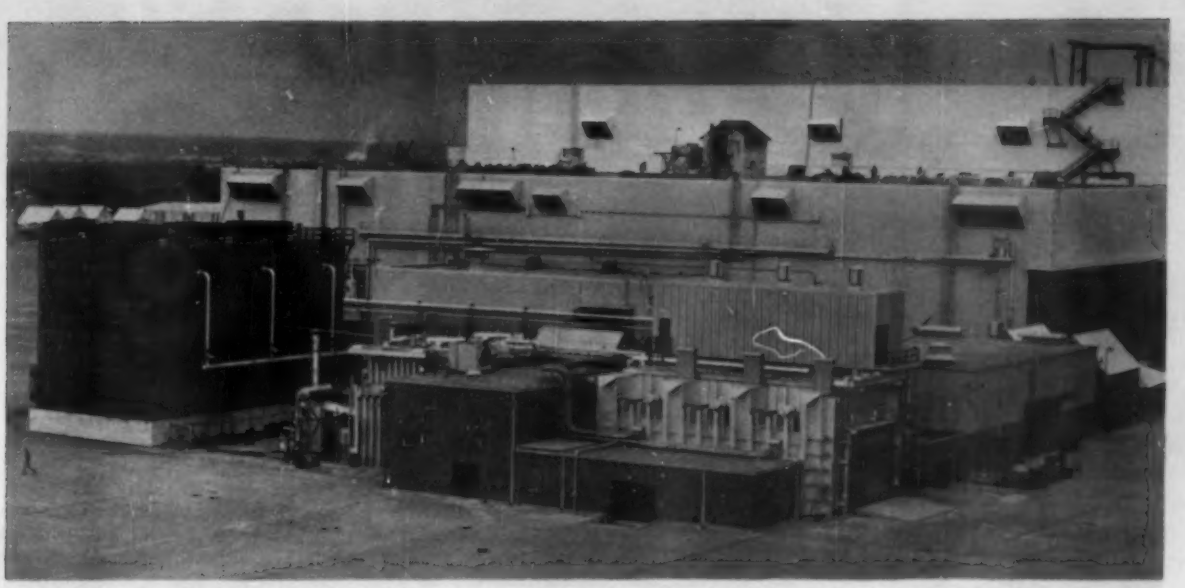


COOLING tower for Convair's high altitude laboratory is at the left. Main control building is the brick structure on near side of the facility. Large test chamber is on the right side of the building; smaller chamber is at the left.

Laboratory Simulates B-58 Environments

Ft. Worth—New $3 million high altitude laboratory has gone into service here which will be used for environmental testing of the complex systems which are integrated into the Convair B-58 weapon system.

Capable of testing entire systems at simulated altitudes up to 100,000 ft., the laboratory went into operation early in April. It will be valuable in the marrying of B-58 systems now in process, according to Henry K. Growald, chief of engineering tests for Convair, a division of General Dynamics Corp.

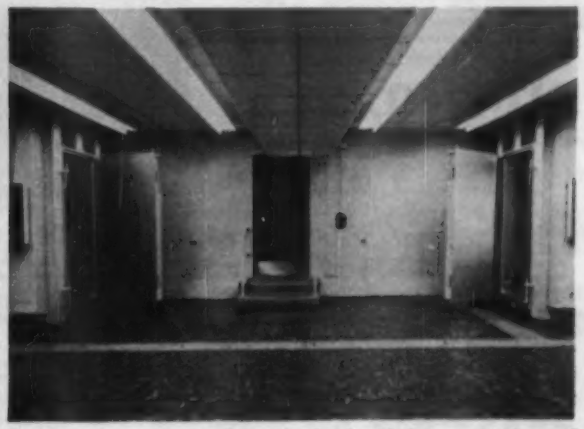
Convair laboratory includes two large test chambers, one of which is 35 ft. wide, 50 ft. long and 14 ft. high. The second chamber is 20 ft. wide, 35 ft. long and 14 ft. high, and this unit can be partitioned into two chambers of equal size. All of these units can be operated at the same time.

Environmental laboratory is used to test electronic, hydraulic and pneumatic systems, but about 75% of the work will be with electronic systems because of the heavy orientation of aircraft such as the B-58 in that direction.

Simulated Altitudes

These systems can be tested in simulated altitudes from sea level to 100,000 ft. Smaller chamber can be taken from ambient conditions to 40,000 ft. in one minute, to 60,000 ft. in two minutes, to 75,000 ft. in three minutes and 100,000 ft. in 10 min. These conditions are reached at an air bleed rate of 150 ppm. It takes 30 min. to get the largest chamber to 100,000 ft.

Temperature capabilities range from −100F to 400F. Heater for the large chamber is rated at 5.5 million Btu./hr., and the heater for each half of the partitioned smaller chamber is rated at 2.5 million Btu./hr. Refrigeration system is rated at 100 tons at −85F at sea level, and by storing large amounts of cold brine, rated capacity can be exceeded for rapid temperature pulldowns. Humidity can be varied from 20% to 95%



LARGEST laboratory chamber (left) is 35 ft. wide, 50 ft. long and 14 ft. high. Panels along wall can be fitted with instrumentation and power leads. At right, heavy doors open into air locks which connect the main control building with test chambers.

DIT-MCO Is Faster and More Reliable Than Other Methods

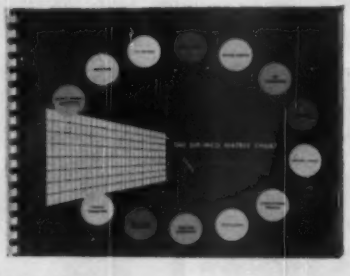
Take tape read-out tests, for example. This method requires extra machines to translate test information or a genius to remember the code used on the tape. Either way, it's a costly process. Compare this to the DIT-MCO Automatic Circuit Analyzer and its exclusive Matrix Chart.

The DIT-MCO Circuit Analyzer performs the entire test itself. There's no need for complex machines to translate test information. All data concerning errors, circuit numbers, type of flaws, etc., appears on the Matrix Chart, so there's no need for complicated wiring diagrams or charts! And, the DIT-MCO Circuit Analyzer checks one circuit against all others . . . over 2,000 in about three minutes . . . with accuracy never before possible in any test system.

Some testers are a maze of colored, flashing lights. Operators of such test machines must refer to 100, 500 or even 1,000 miniature lights to try and locate errors. Charts and diagrams must also be used . . . with a resultant high number of human errors.

The DIT-MCO Circuit Analyzer injects human decision into every test but in such a way that chances of human errors are nil. The easy-to-read Matrix Chart employs only two lights to quickly pinpoint every circuitry flaw. Yet, anyone, with less than one hour's instruction, can operate the DIT-MCO Automatic Circuit Analyzer and perform test functions once thought impossible!

These are just a few reasons why DIT-MCO is faster and more reliable than other methods in electrical circuitry tests. Why not get the complete story? Write today for free Matrix Chart booklet.



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relative between 35F and 185F dry bulb.

Electrical circuits are provided for continuous operation at 3,000 kva. or two minute operation at 6,600 kva.

Growald points out that the laboratory has considerable flexibility in that three chambers can be operated simultaneously at different altitude, temperature and humidity conditions. Test chambers are large enough for environmental testing of large components or complete systems, and support equipment, which is not being tested, can be accommodated outside the chambers with leads running through special panels to the test unit in the chamber.

Control Room

In addition to space for support equipment, the laboratory has a separate control room where the chambers are operated and where test runs are recorded. Chamber walls have a number of windows and several small removable panels. These panels are replaced with special panels as necessary to feed instrumentation and electrical, hydraulic or pneumatic power to units being tested.

Chamber walls are about a foot thick and are made of stainless steel with aluminum foil and foam glass blocks for insulation. They are braced by I-beams on the sides and across the bottom and by box beams across top.

Each chamber has a large door at one end which provides access nearly as great as the area of the end wall. Access is also provided through air locks in which pressure can be equalized with either the test chamber or the main control room.

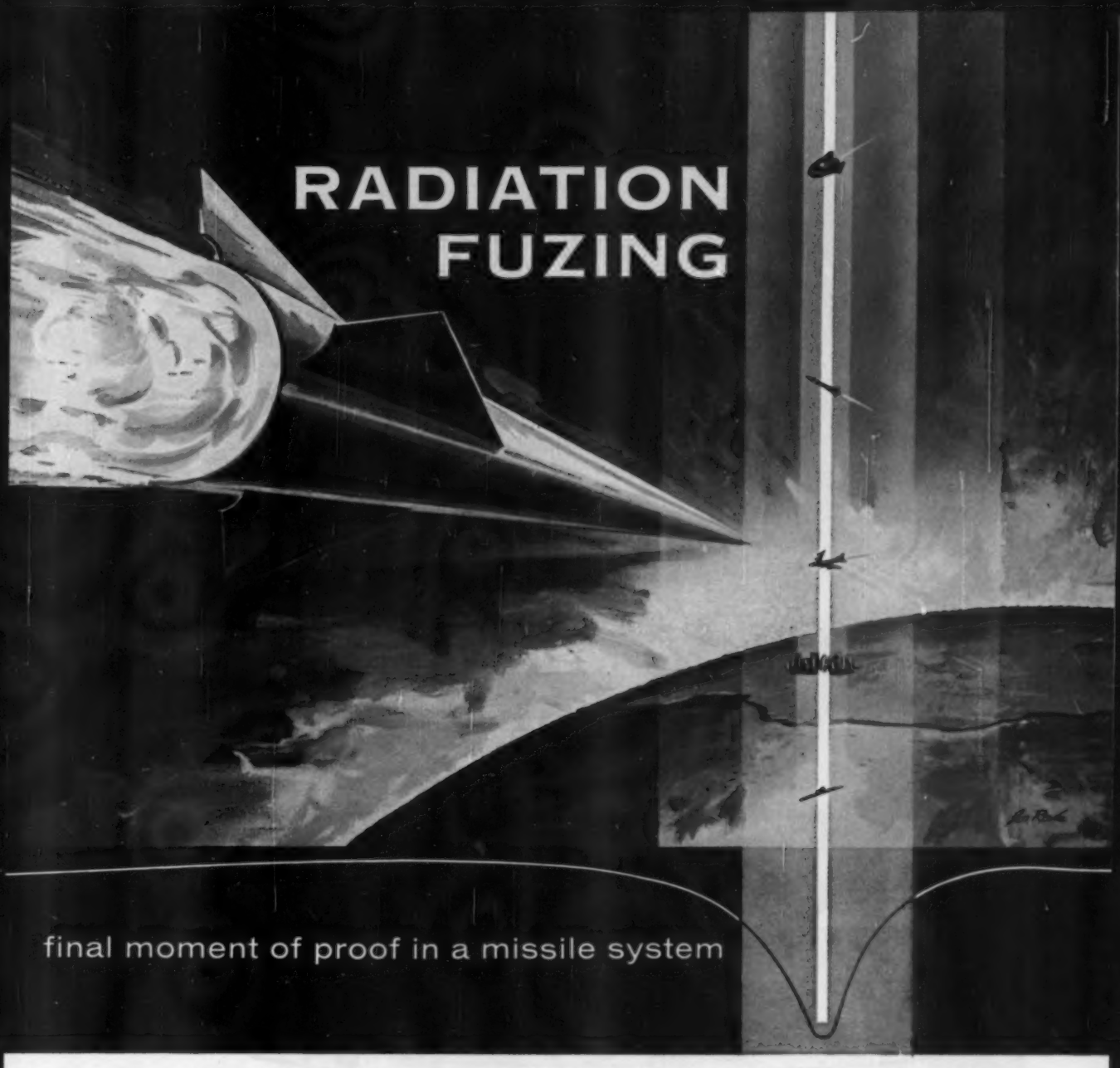
Along with the chambers, the laboratory consists of two test control and instrumentation buildings; a steam jet ejector vacuum system; a multistage refrigeration system; a 300 lb./min. high pressure, high temperature air system; a cooling water system; chamber heating systems; an equipment building, and control and instrumentation systems.

General Electric Tests Turbofan CJ-805-23

General Electric is testing an advanced version of the CJ-805-3 turbojet engine which incorporates an aft-fan component.

Designated the CJ-805-23, the turbofan is said to have demonstrated increased thrust and improved fuel consumption, with design changes held to a minimum.

Weight increase over the CJ-805-21 turbofan is about 25 lb. The -21 is the powerplant planned for the Convair 600 jet transport; the -3 powers the Convair 880.



There are hundreds of moments of proof in the life-span of a missile system, but the final, and most dramatic, is that split-second when the radiation fuze fulfills the purpose of the mission. There may be no time for a "second shot".

The critical problems of high closing rates in air and space, of ground and submarine target discrimination and sensitivity, and of improved countermeasures in all areas, demand fuzing techniques which will not fail the technical integrity of the complete missile system. Such fuzes must be subminiaturized and ruggedized to provide absolute reliability and precision under re-entry and other extreme environmental conditions.

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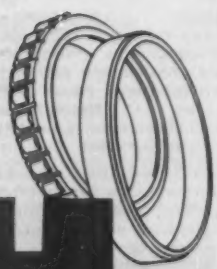

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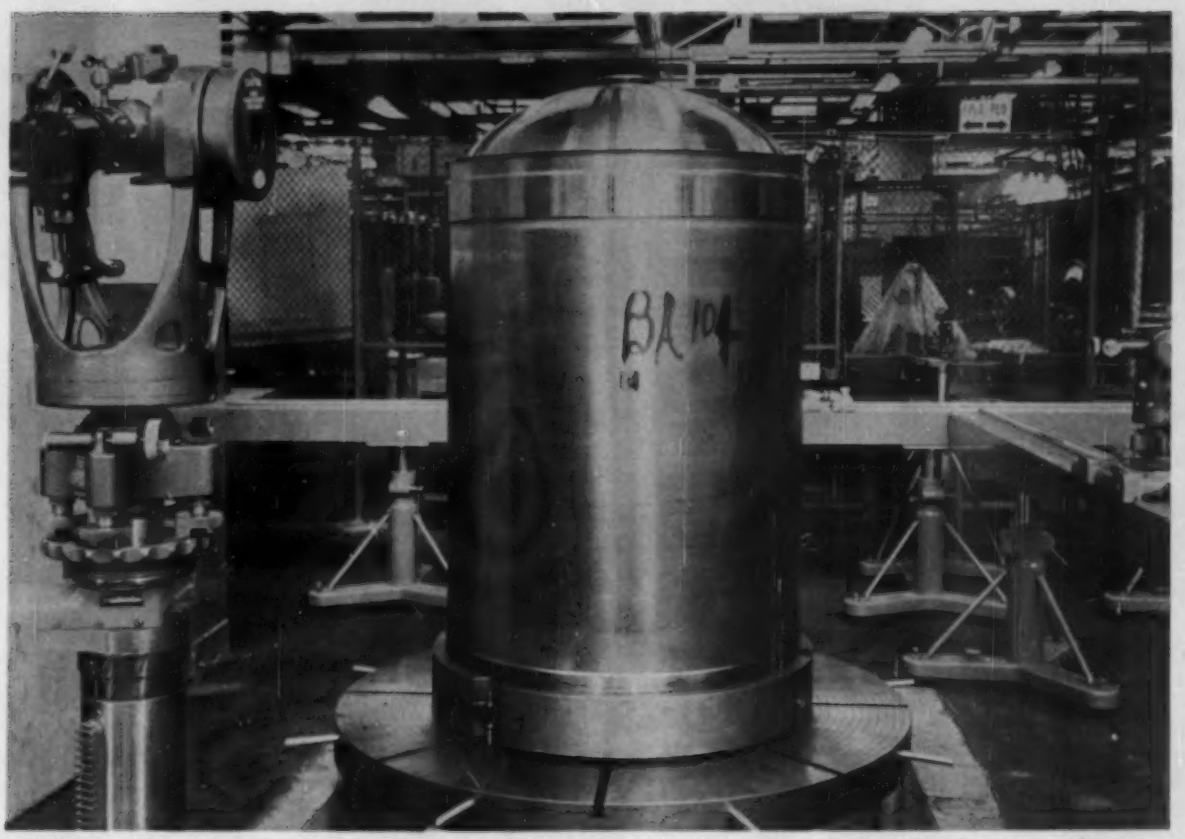

TOP HALF of Minuteman second stage casing is optically inspected to make sure it is a true cylinder and conforms to specifications.

Roll Forming Tried on Minuteman Casing

By Michael Yaffee

Evendale, Ohio—A metal shaping process called roll forming is making its bid here for major missile applications. Primary goal is a production contract for the Minuteman second stage casing which will be awarded sometime between July and September.

One of approximately a half dozen subcontractors to Thiokol Chemical Corp. on the second stage casing, General Electric's Rocket Engine Section is roll forming a number of experimental casings which will be among those used by Thiokol in competition firings with Aerojet-General for the second stage production contract. The company has also entered its roll-form casings in the competition for the Polaris production contract which is now up for award. And just recently, General Electric engineers have started to discuss roll forming with Thiokol as an approach to the fabrication of the first stage casing for the Minuteman.

At present, however, roll and weld

DISH FORGING to which blast tubes are attached shows distinctive pattern resulting from contour machining. Dish will be attached to bottom of second-stage casing.

a.

NEW TITANIUM ALLOYS, IMPROVED PROPERTIES FOR

Several new titanium alloys may prove to be the answer to designers' needs for improved tensile and fatigue strength, ductility and corrosion resistance in aircraft and spacecraft materials.

One of the alloys is Crucible B-120VCA. This new, weldable alloy has the highest strength/weight values of any structural material available. At 220,000 psi, its strength/weight ratio is equivalent to that of steel at 360,000 psi. And it maintains its strength/weight advantage for short times at temperatures up to 1400° F. Furthermore, B-120VCA is "Formageable"® (readily formed in the "soft" solution annealed condition and then strengthened by age-hardening).

As this is written, about 50 aircraft and missile manufacturers are testing Crucible B-120VCA samples. They're reporting: (1) it's easier to fabricate than any other titanium alloy; (2) it seems ideal for rocket motor cases, structural members, rivets and other components.

Several other critical design problems are being solved by Crucible vacuum-melted steels and superalloys. Some Crucible alloy and tool steels, for example, possess tensile strengths in the 280,000/300,000 psi range and even higher. Up to now, getting uniform transverse ductility at this strength level has been a problem. Crucible solved it through vacuum melting.

These developments are typical of Crucible advances in specialty steelmak-

b.

c.

a. Lowering a consumable electrode into a vacuum arc furnace. Metals produced by vacuum melting are "cleaner" and therefore offer improved strength, ductility and longer fatigue life.

***b. Titanium,** more than 1000 lbs. of it, saves 800 lbs. in Convair 880 because of metal's high strength/weight ratio. Principal use is in jet engine pods, aileron, stabilizer, and tail assembly.*

***c. Crucible Vacuum-Melted Bearing Steel** makes stronger, longer-lasting bearings. Rejects during manufacture and early failures are virtually eliminated.*

***d. Vacuum-Melted 4340** was specified for hook pivot pin of bomb rack and rocket launcher when air melted steels failed to withstand 4½ hour destructive vibration tests.*

d.

HIGH PURITY METALS PROVIDE MISSILE DESIGNERS

ing. They're possible because Crucible is completely integrated—and because Crucible pioneered in the development of titanium, the high temperature alloys, and in vacuum induction melting and vacuum arc remelting techniques.

Today, Crucible's experience—and newly-increased capacity for vacuum arc remelting of its own special air melted and vacuum induction melted electrodes—provides industry with a complete range of High Purity Metals at lowest cost.

If you'd like to know more about this work, read: "Titanium for Aircraft and Spacecraft" and "Quality Aspects and Engineering Properties of Vacuum Melted Super Alloys and Steels". Write: *Crucible Steel Company of America, Dept. AE17, The Oliver Bldg., Mellon Square, Pittsburgh 22, Pa.*

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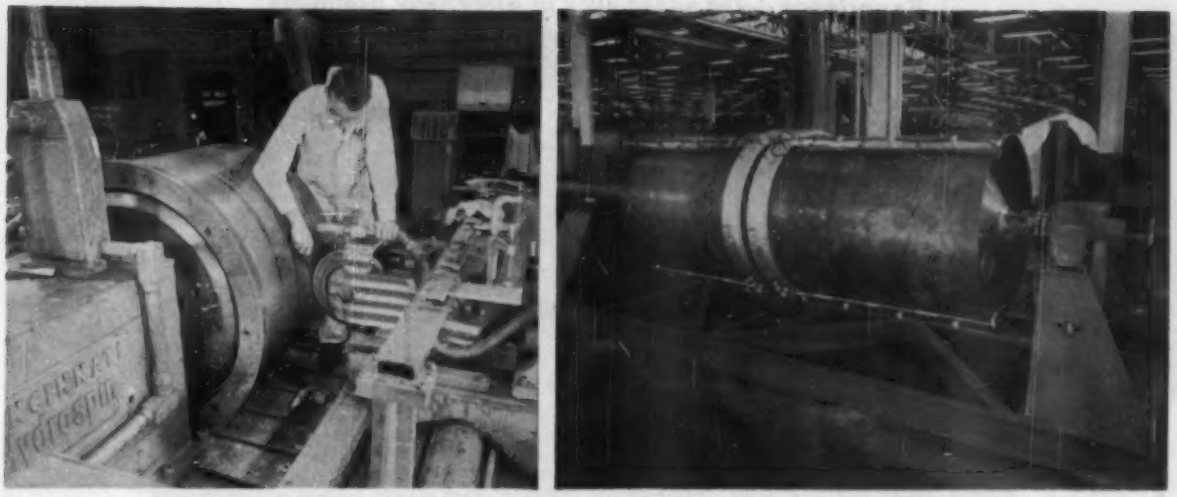
fabrication appears to be the choice metal shaping method on the first stage. The Minuteman's third stage solid propellant engine casing, a number of engineers now believe, will be the glass fiber unit now under development by Hercules Powder Co. Currently the most contested area is the approximately 9-ft. casing between the two.

Basically, there are four shaping processes in contention on the Minuteman program. There is roll forming wherein a forging is cold rolled out to approximately twice its original length and one half its original thickness. There is roll and weld in which a steel sheet is rolled into a cylinder and longitudinally welded. Another method involves the welding together of a series of machined ring forgings to form the cylindrical casing. The fourth approach is ribbon wrapping wherein a steel band is wrapped around a form and bonded together.

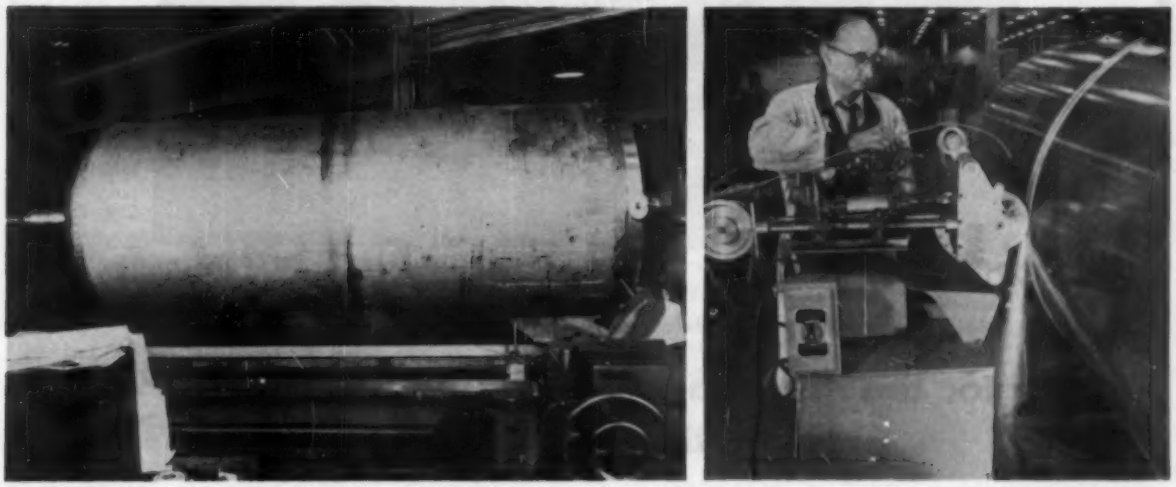
In addition to General Electric, Curtiss-Wright, Allison Division of General Motors, Kaiser Industries, Solar Aircraft and the Budd Co. are among those reported to be working on the project either under subcontract to Thiokol or Aerojet-General. Aerojet is also doing some work itself on casing fabrication.

During the competition, several vehicles made by each of these methods will be fired. After it is decided which casing worked out best, there will be competitive bidding by those companies

AFTER outside of the girth weld is ground smooth, casing is placed in vertical rig so inside of weld can be ground.



MAIN BODY of ring forging, on the mandrel at left, is rolled out to form the bottom section of the Minuteman second-stage casing. The top and bottom sections are placed in a horizontal rig (right) where they will be welded together.



CLOSURE JOINT on the bottom of the second stage Minuteman casing (left) is ground to its finished surface with a small abrasive wheel. The machinist at right is grinding the outside of the girth weld joining the two sections of the casing.

that used the same method as that used on the winning casing, and the production contract for the second stage Minuteman motor case will probably be awarded on the basis of price.

To assure multiple supply sources, more than one contract is expected to be awarded. Theoretically, even those not using the winning fabrication method will be able to bid for the production contracts. But the others, particularly the company which produced the "winning" entry, will likely be favored. For one thing, they will already have a good share of the required fabricating equipment on hand.

The equipment used in roll forming is expensive. But on a production basis, says General Electric, this process will prove less expensive than the roll and weld method which is currently the least expensive approach. Roll forming will also be faster than roll and weld. But most important, according to General Electric, are the roll-formed casing's superior strength and lighter weight. As produced by General Electric, the Minuteman second stage will have one girth weld at approximately the middle of the casing, compared with the welded seam running the length of the casing in the roll and weld method.

Hoop Stress

Because hoop stress is about double longitudinal stress, the girth weld will "see" only one-half the stress of the longitudinal weld. Moreover, General Electric claims it is able to make a girth weld that is as strong as the parent material as compared with the usual weld which is generally about 85-90% as strong.

The ring forging approach also makes use of girth welding, but it will require more than one weld and perhaps as many as five for the second stage casing of the Minuteman. Wrapped steel ribbon casings, representing the fourth approach under consideration, still do not show too much promise, at least at this time, of being able to do the job.

In addition to the comparatively light weight and high strength of the end products, and the speed and low cost of volume production, roll-forming has the advantage of starting with relatively simple, easy to obtain shapes which hold close tolerances, General Electric says. Moreover, the method, which is only now coming into its own as a fabricating technique for major missile components, appears to lend itself particularly well to all solid propellant rocket casings.

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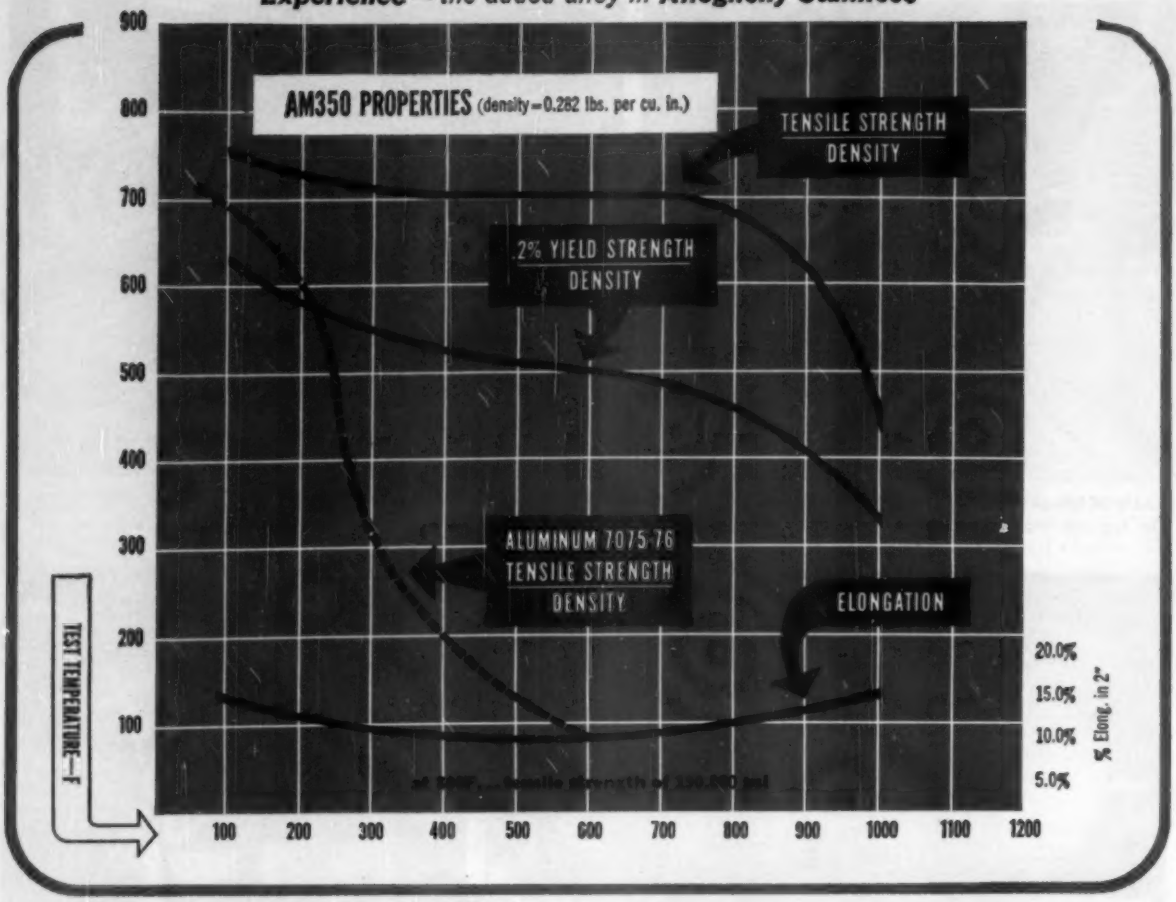

Two for the space age—AL's AM-350 and AM-355 precipitation hardening steels

A unique combination of highly desirable properties describes Allegheny Stainless AM-350 and AM-355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many space age problems. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM-350 and AM-355.

AVAILABILITY: AM-350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM-355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars and wire.

CORROSION RESISTANCE: Compared to the more familiar stainless grades, AM-350 and AM-355 resist corrosion and oxidation better than the hardenable grades (chromium martensitic) and only slightly less than the 18 and 8's. They resist stress corrosion at much higher strength levels than do martensitic stainless grades.

SIMPLE HEAT TREATMENT: High strength is developed by two methods. Both minimize oxidation and distortion problems. The usual is the Allegheny Ludlum-developed sub-zero cooling and tempering (SCT): minus 100F for 3 hrs plus 3 hrs at 850F. Alternate method is Double Aged (DA): 2 hrs at 1375F plus 2 hrs at 850F.

EASY FABRICATION: AM-350 and AM-355 can be spun, drawn, formed, machined and welded using normal stainless procedures. In the hardened conditions, some forming may be done . . . 180 degree bend over a 3T radius pin. Also AM-350 can be dimpled in the SCT condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM-350 and AM-355." ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dpt.AW-17***

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ing, General Electric's Rocket Engine Section is now talking to Thiokol about the possibility of fabricating the first stage of the Minuteman by roll forming as well. While this could be done on present equipment, General Electric engineers prefer to wait for the installation of its new, large rolling machine next month before discussing the first stage project in detail.

The largest roll flowing machine the company now has is a 47-in. x 50-in. unit. (The first figure is the inside diameter of the forging that the machine will accommodate, while the second is the distance that the rollers can traverse.) The new equipment will be a 75-in. x 100-in. machine.

Major steps in General Electric's fabrication of Minuteman second stage casing, which are carried out for the most part on the 47-in. x 50-in. roll form machine, are as follows:

First, General Electric buys the forgings. Three are required for each second stage. One is a ring forging which is formed into the aft section; one is a deep draw forging for the top section; the third is a dish forging which fits into the bottom of the aft section and to which the blast tubes are attached. The material is International Nickel Co.'s 300-M (formerly called Tricent), a low alloy, high purity steel with a yield strength of 240,000-260,000 psi. and a tensile strength of 280,000-300,000 psi.

Aft Forging

The aft forging has a diameter of a little under 4 ft. with a wall thickness of roughly ½ in. and stands 28-30 in. high. General Electric machines the outside diameter to its final dimension and the inside diameter so that it will fit onto the mandrel of the rolling unit. The forging is shoved against the head stock of the roll forming machine and held in place by a support fixture pressing against the other end of the forging. The support fixture fits into a small groove in what will become the bottom of the aft section.

The initial roll forming operation is the rolling of the skirt which fits inside the first stage and attaches the two. Formed from the small area on the aft forging which is the outer rim of the groove for the support fixture, the skirt is actually rolled out over the support fixture. The rollers, exerting a pressure against the outside of the forging slightly greater than the yield strength of the steel, move toward the head stock as they turn and the metal is back extruded; that is, pushed out in the opposite direction. Fluid flowing over the rollers as they work serves as a lubricant.

After the attachment skirt is rolled, the support fixture is removed to permit back extrusion, and the main cylindrical section of the aft forging is rolled. It is roll formed with one pass of the rollers

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at a 50% reduction; that is, the wall of the cylinder is squeezed to half its original thickness and the cylinder grows to approximately twice its original length.

The same operations are then repeated on the forward section. First, it is machined, bored and placed on the mandrel. Then the skirt which forms the attachment for the third stage is rolled out over the holding fixture. The support is removed and the forward section is roll formed in one pass at a 50% reduction.

Unlike the aft section which starts out as a ring forging, the front section is a deep draw forging, looking like a large tumbler with a rounded bottom. The curved end, which actually becomes the top of the second stage casing, features a small, hollow flange protruding outward slightly from the center of the convex side of the curved end. This is the igniter boss.

Cover Forming

At the same time the top and bottom sections are being formed, the cover (to which are attached the blast tubes) is being machined. This unit starts out as a slightly domed, dish forging. It is placed on a special die and four holes are pierced through it, forming small ridges on the convex side, around each of the four openings. After it is pierced, the cover undergoes contour machining which leaves a patterned surface. A closure joint is machined into the edge of the cover to match a similar joint in the bottom of the aft section of the casing. After a final machining, four blast tubes are welded to the ridges around the openings in the cover.

Next, the rolled top and bottom sections are subjected to a careful optical inspection to make sure they are true, placed in a horizontal welding fixture and girth welded together. The outside of the welded joint is ground smooth. Then the casing is placed in a special vertical fixture used for grinding the inside of the welded joint.

The closure joint in the aft section of the casing is premachined and the final surface of the closure joint is obtained during the grinding operation as the casing is slowly rotated. Then, in the final stage of assembly, the cover with its four blast tubes is attached to the aft section of the casing by means of their special keyed closure joints. The last step in the over-all operation is the hydrostatic pressure test in which the second stage casing is filled with water and tested for strength.

While these are the principal operations in General Electric's roll flowing fabrication of the Minuteman second stage, there are, of course, many other smaller but still important ones that must take place throughout the assembly. There are, for example, many inspections besides the important optical

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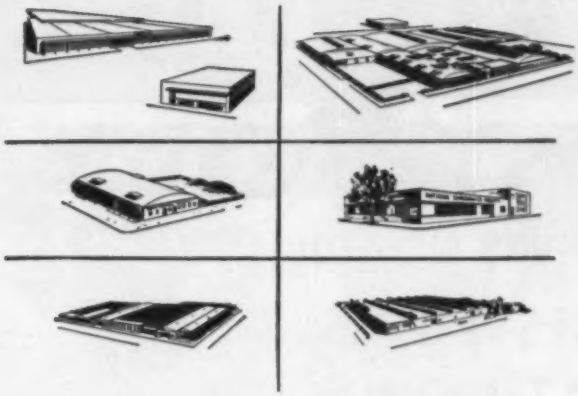

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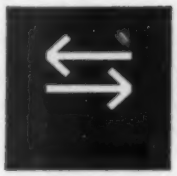

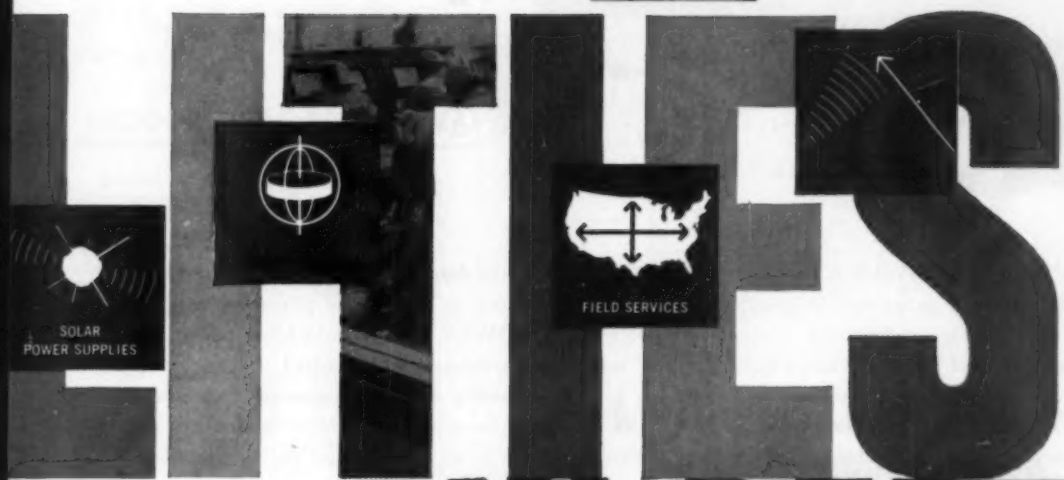

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inspection already mentioned. Too, at certain stages, the casings undergo heat treating.

As to the possibility of roll forming an integral case from a single forging, General Electric engineers reply that it is definitely possible but would prove much more expensive. Among other things, it would involve the use of a collapsible mandrel and would require a very large roll forming machine with a long bed. Moreover, they feel there is little to be gained by such an operation since their girth weld is as strong as the parent material.

Although the first roll forming machines were built about six years ago, it is only now that missile people are beginning to think about using them to make solid propellant casings. The need for lightweight casings that can be made by this method did not manifest itself, says General Electric, until the specific impulse of the solid propellants themselves reached the point where solids could be considered for use in the large, long range missiles. Then low weight casings and high mass ratios became most important. The Minuteman, for example, is designed around a mass ratio (above .90) that was unheard of two years ago.

PRODUCTION BRIEFING

Lycoming mechanical 20 kva. constant speed drive completed Navy qualification tests under MIL-T-7101A specifications at the Naval Air Development Center, Johnsville, Pa. The 55 lb. constant speed drive, Model LD3-3, will be produced at the Avco Division's Stratford, Conn., facility.

Elliott Brothers Ltd., London, England, will produce integrated dual automatic pilot, flight director and polar path compass system for the Vickers-Armstrongs VC-10 under $5.5 million contract.

Summers Gyroscope Co., Santa Monica, Calif., will build gyroscopic units for guided missiles under contracts totaling $1,225,000 from the Martin Co. One award, in excess of $1 million is for spring-wound gyros for use in Navy's Bullpup.

Waste King Corp.'s Technical Products Division, Los Angeles, will build gear drives of aerial refueling hose reels for the North American A3J.

U. S. Science Corp., subsidiary of Topp Industries, Inc., Los Angeles, will produce angle of attack systems, Lockheed P3V cabin temperature controls and Barodyne pressure controls for testing fire controls in the Convair F-102. Total value of the new contracts is approximately $2 million.

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Great Lakes Mfg. Corp., 4223 Monticello Blvd., Cleveland 21, Ohio

Pressure Regulator

Hand pressure regulator for air, nitrogen or helium use, is intended for missile ground support test equipment, missile flight units and production.

Hand loader is adjustable from 3,000 psig. to zero. Maximum operating pressure upstream is 4,000 psig. and 3,000 psig. downstream. Proof pressure is 6,000 psig. upstream and 4,500 psig. downstream. Flow area is .003 squared for the 1.2 lb. regulator. The ambient temperature range is from −65 to +160F.

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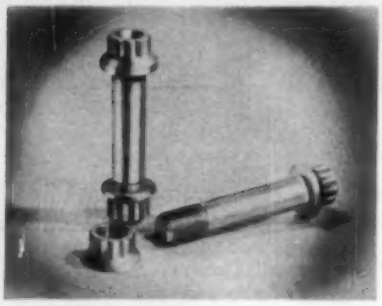

wrenching heads. Bolts are made of 5% chrome steel of the Vascojet 1000 type; temperature limit is 550F. Diameter sizes of #10 to 1¼ in. are available.

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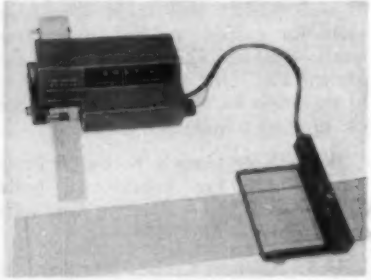
Data Reduction Instrument

Data reduction instrument for flight test programs reads oscillogram and strip chart amplitudes up to 6½ in. and prints this information on adding machine tape.

Tabulator, called the GOAT (Ger-



ber oscillogram amplitude tabulator), consists of a stationary printing counter and a hand-held rectangular frame with a variable hairline. The linear speed of the hairline may be varied with change gears so that the digits read

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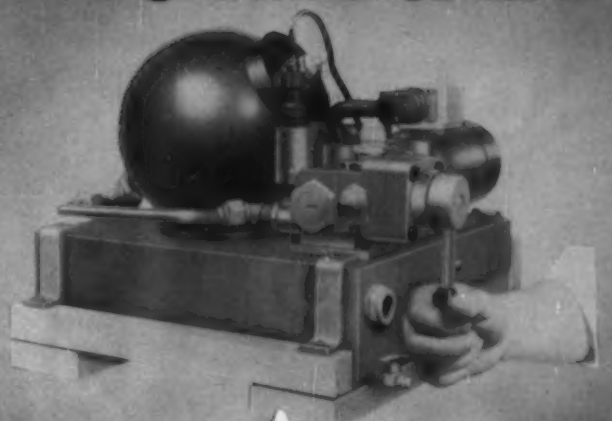

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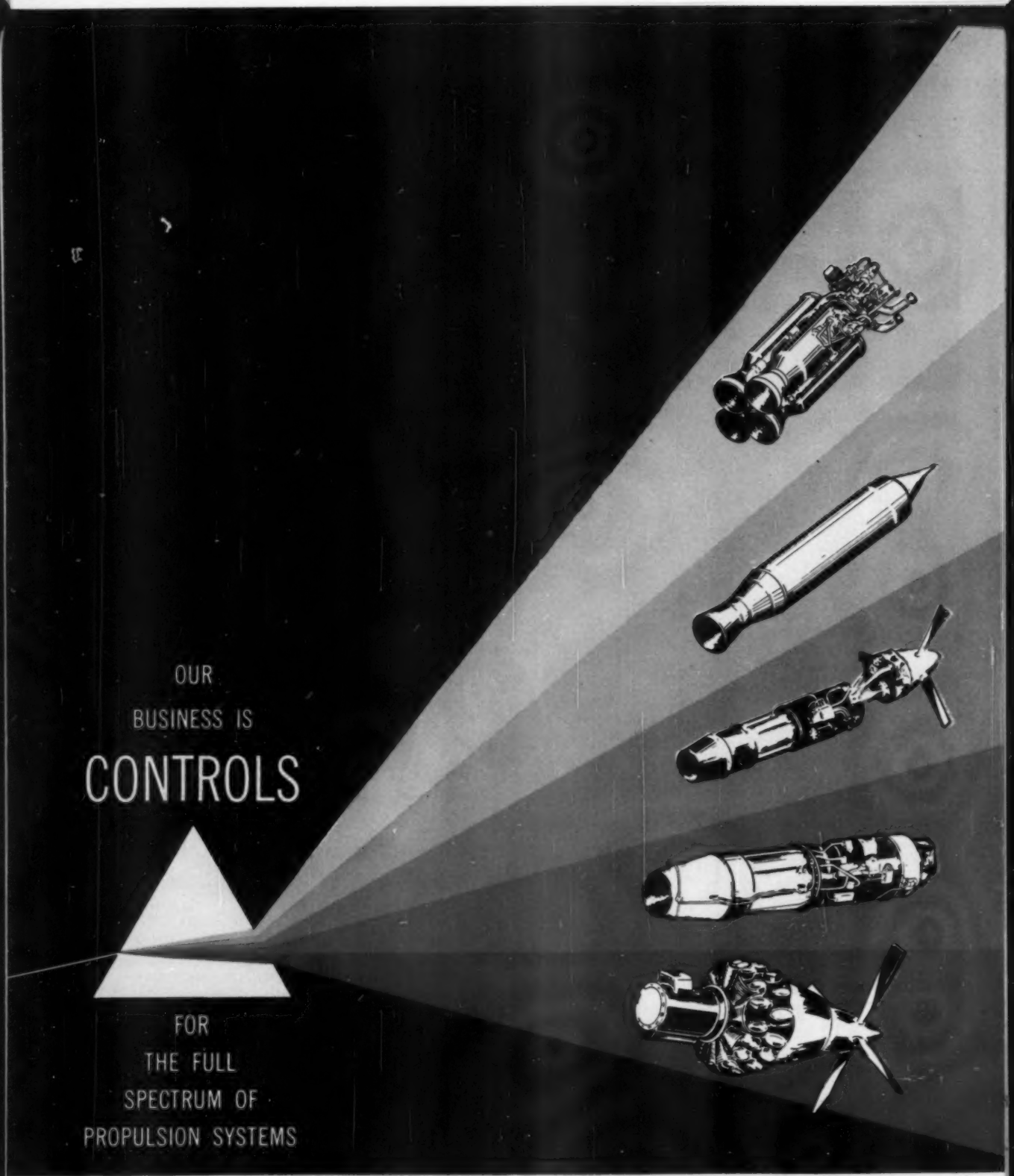

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Bendix AVIATION CORPORATION

FAA to Test Gilfillan Landing System

By Russell Hawkes

Los Angeles—Automatic landing system being developed here by Gilfillan Bros. under Federal Aviation Agency sponsorship is expected to combine some of the best operational features of instrument landing system and ground control approach, but has greater flexibility and precision than either of the present approach aids.

Company reports that tests on breadboard equipment, conducted at Rome Air Development Center, revealed maximum error in determining airplane altitude of only eight inches, at altitudes between 5 and 47 ft. and at distances of 400 to 2,300 ft.

Known as Range and Elevation Guidance for Approach and Landing, or Regal for short, the prototype system is scheduled for delivery in August for evaluation at FAA's National Aviation Facilities Experimental Center in Atlantic City, N. J.

Although an azimuth guidance capability will be added if the system goes into production, FAA will evaluate basic techniques only for elevation angle approach, the most difficult aspect of the landing problem.

Like GCA, Gilfillan's system employs a ground-based transmitter operating in the microwave region, although it is not a radar in the conventional sense. Like ILS, Regal provides a cockpit-derived glide-slope type signal, but gives each aircraft a wide choice of approach angles, ranging from 1½ to 20 deg. elevation angle. Approach angles of 45 deg., perhaps even 80 to 90 deg., may be possible in production versions. In addition, the system provides the pilot with an accurate indication of his distance from touchdown.

In effect, Regal creates a fixed reference grid with respect to the touchdown point on the runway and continuously indicates each aircraft's position in terms of distance, elevation angle and azimuth angle (in a production version). When coupled into an airborne flareout computer and autopilot, Gilfillan says the system's precision will permit fully automatic landings.

Features of System

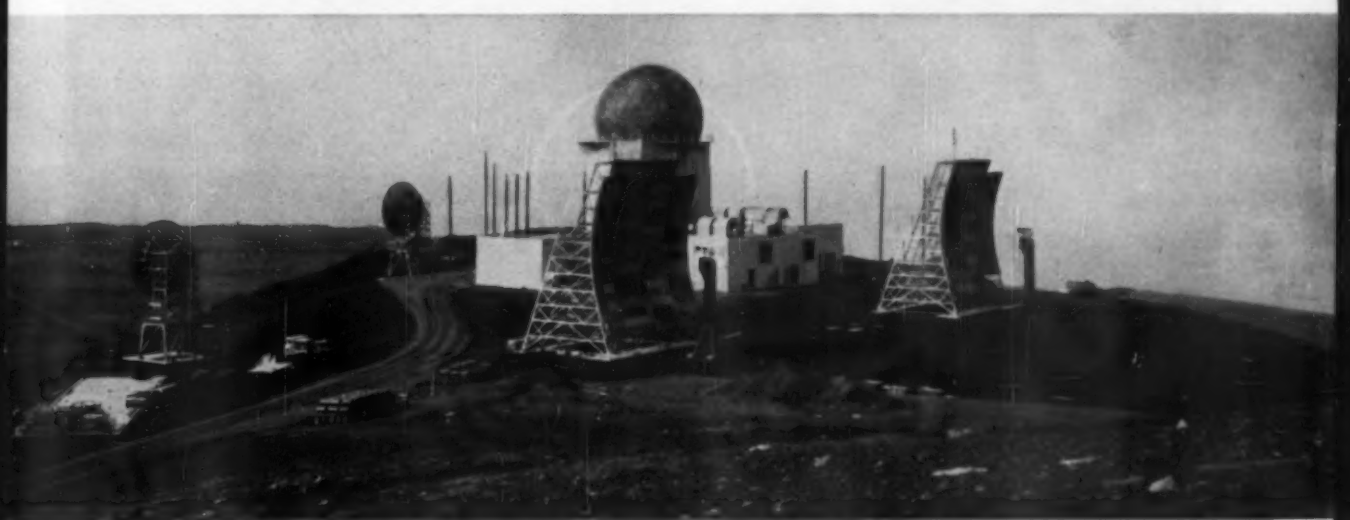
Features of the system, cited by Gilfillan, include:

- **Unlimited capacity:** Unlike GCA, there is no reasonable limit to the number of aircraft which can simultaneously use Regal for approach guidance.
- **Flexible approach paths:** Unlike GCA and ILS, Regal offers a variety of different possible elevation and azimuth approach paths to accommodate a variety of types of aircraft, ranging from jets to helicopters and vertical takeoff and landing aircraft.
- **Light airborne equipment:** Airborne receiver-decoder required is expected to be small, and to weigh less than 15 lb.
- **Precision guidance:** Regal is expected to provide indication of approach angle which is accurate to within at least 0.05 deg.
- **Wide coverage:** System can be designed to provide wide azimuth and elevation coverage, greatly reducing aircraft acquisition problem.
- **Manual or automatic:** Regal can provide conventional ILS-type cross-pointer cockpit indication for manual flying or be tied into autopilot for automatic approach.

The Gilfillan system, originally begun as a military development, is part of a broad program by FAA to provide improved instrument approach and landing capability. This includes immediate improvements for existing ILS and GCA and evaluation of the Bell Aircraft AN/GSN-5 automatic landing system (known as AN/SPN-10 in its Navy carrier version).

Regal employs a ground-based radar-type transmitter, operating at X-band, and an antenna which produces an extremely narrow beam, 0.02 deg. in width, that scans vertically. Prototype equipment will scan from a 20-deg. vertical angle down to 1½ deg. approximately five to eight times per second.

At each beam elevation angle, the transmitter sends a distinctive series of pulses which indicate the elevation



New DEW Line Chain Guards Aleutians

To prevent Soviet bombers from making undetected end runs around the northern DEW Line across Alaska and Canada, six new radar stations, like one above at Cape Sarichef on Unimak Island, have been completed by USAF along the Aleutian Island chain.

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angle of the beam at that instant. These are received by the aircraft's receiver-decoder only when the aircraft is illuminated by ground antenna's scanning beam. At such time, receiver-decoder opens to accept the pulsed signal, decodes it into an indication of the beam (and airplane's) vertical approach angle.

Immediately following aircraft illumination by the narrow beam, and receipt of the beam elevation message, the airborne unit sends a pair of pulses which cause the ground transmitter to reply with a similar pair of pulses. By measuring time interval between transmission and receipt of the ground reply, the airborne unit determines the distance to the runway in much the same way that DME-T operates. Distance measuring accuracy is expected to be within 1%. However, considerably less circuit complexity is required for Regal because each aircraft interrogates the ground station only when illuminated by the beam instead of in completely random fashion as with DME-T.

In a production version of Regal, azimuth guidance would be provided in similar fashion. However, the azimuth antenna could be located at the head of the runway to provide directional control throughout the rollout. Transmissions from azimuth and elevation antennas would be synchronized and transmitted alternately.

Technical Details

To minimize ground reflection problems, Gilfillan has not only used an extremely narrow beam, but transmits only during the downward scan, not during reverse cycle from ground upward.

Combination coarse-fine technique is employed to transmit information on beam elevation angle to provide 0.02 deg. resolution. A train of seven pulses, one of which is a reference pulse, indicates antenna beam/aircraft elevation angle to within 0.325 deg., using a binary code. This train of pulses is followed by up to 15 additional pairs of pulses which are counted by the receiver-decoder. Each pair of pulses counted signifies an additional increment of 0.02 deg. For instance, if the initial seven-pulse train indicates elevation angle of 6½ deg., and is followed by 10 additional pairs of pulses, the airplane's elevation angle is 6.7 deg. (6.5 x 10 x 0.02).

Because the airborne receiver-decoder operates from primary (not reflected) microwave energy, a simple crystal video receiver can provide ranges of more than 10 mi. using a ground transmitter whose peak power is 150 kw., Gilfillan says. Ground-based equipment required for Regal is considerably less complex, and less costly than for conventional GCA.

A simple monitor can be installed along the approach path to continuously check performance of Regal system by comparing transmitted elevation angle against known angle. This is similar to monitors used with existing ILS systems. Airborne equipment can be checked out against the regular ground transmitter prior to takeoff.

The present experimental Regal system is being designed and fabricated under a $381,466 FAA contract.

Expansions, Changes In Avionics Industry

Mitre Corporation, a non-profit company recently organized by Massachusetts Institute of Technology to work with the Air Force on air defense system integration, will build a $2 million facility in Bedford, Mass. Within the next two years, Mitre expects to construct another $3-$6 million in facilities at Bedford.

Other recently announced expansion and changes in the avionics field include:

• **Clevite Transistor** will erect a $3 million plant on Route 128 near Boston. The 125,000 sq. ft. facility is slated for completion early next year.

• **Packard-Bell Electronics Corp.,** Los Angeles, has acquired a majority interest in **Technical Industries Corp.,** Pasadena, Calif., newly-formed company which produces instrumentation and components for atomic reactors.

• **Technical Operations, Inc.,** Burlington, Mass., has acquired substantially all of Microwave Associates' former interest in **Power Sources, Inc.,** which produces transistorized power supplies. Power Sources has moved its entire operation to Burlington plant of Technical Operations, Inc.

• **Philadelphia Insulated Wire Co.** will build a 50,000 sq. ft. facility in Moorestown, N. J., which will house the company's manufacturing operations and general offices. Occupancy is slated for Aug. 15, 1959.

• **Topic Inc.,** Natick, Mass., is the name of a new company formed by consolidation of **Norcross Manufacturing Corp.,** also of Natick, and **Dunleavey Electronics Corp.,** Stoughton, Mass. The new firm will occupy a 10,000 sq. ft. facility in Natick Industrial Park now under construction on Route 9.

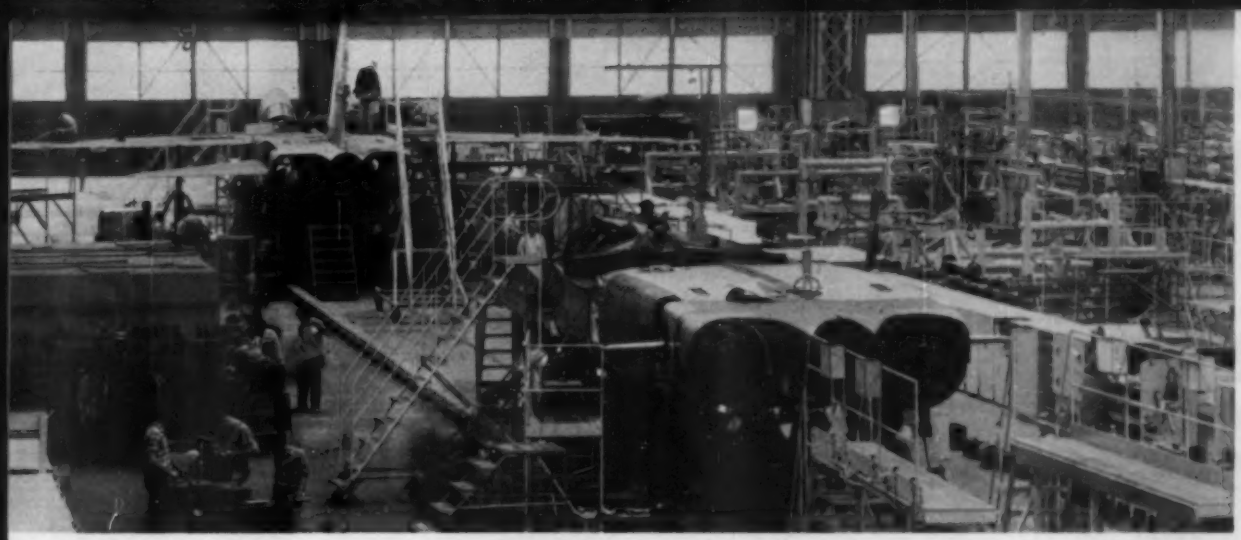
• **Topp Industries** has purchased **U. S. Semiconductor Products, Inc.,** Phoenix, Ariz. Freidrich W. Schwarz remains as president of U. S. Semiconductors. William R. White from Topp becomes general manager.

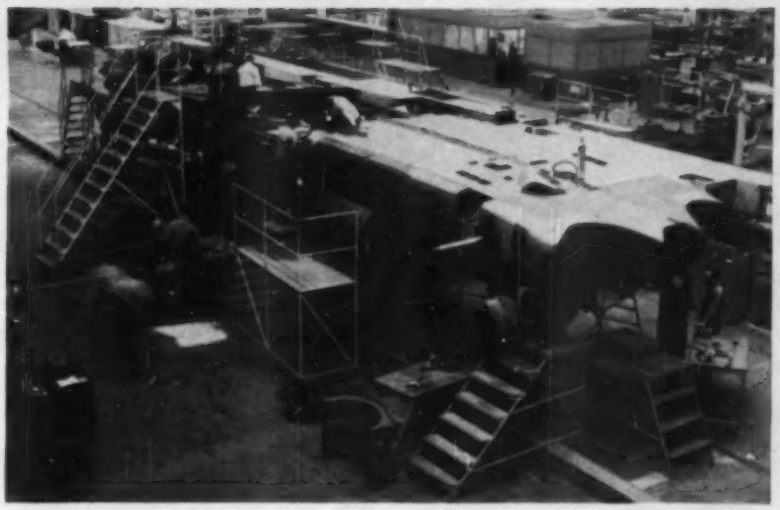
• **Datex Corp.** will build a new 10,000 sq. ft. facility near its main plant in Monrovia, Calif. The company, a subsidiary of G. M. Giannini & Co., Inc., produces digital data processing equipment.

North American Aviation A3J Vigilante attack aircraft in early completion stage is almost ready to roll out from the company's Columbus Division final assembly area. The A3J is currently being flight tested by the Navy before being assigned to heavy attack squadrons.

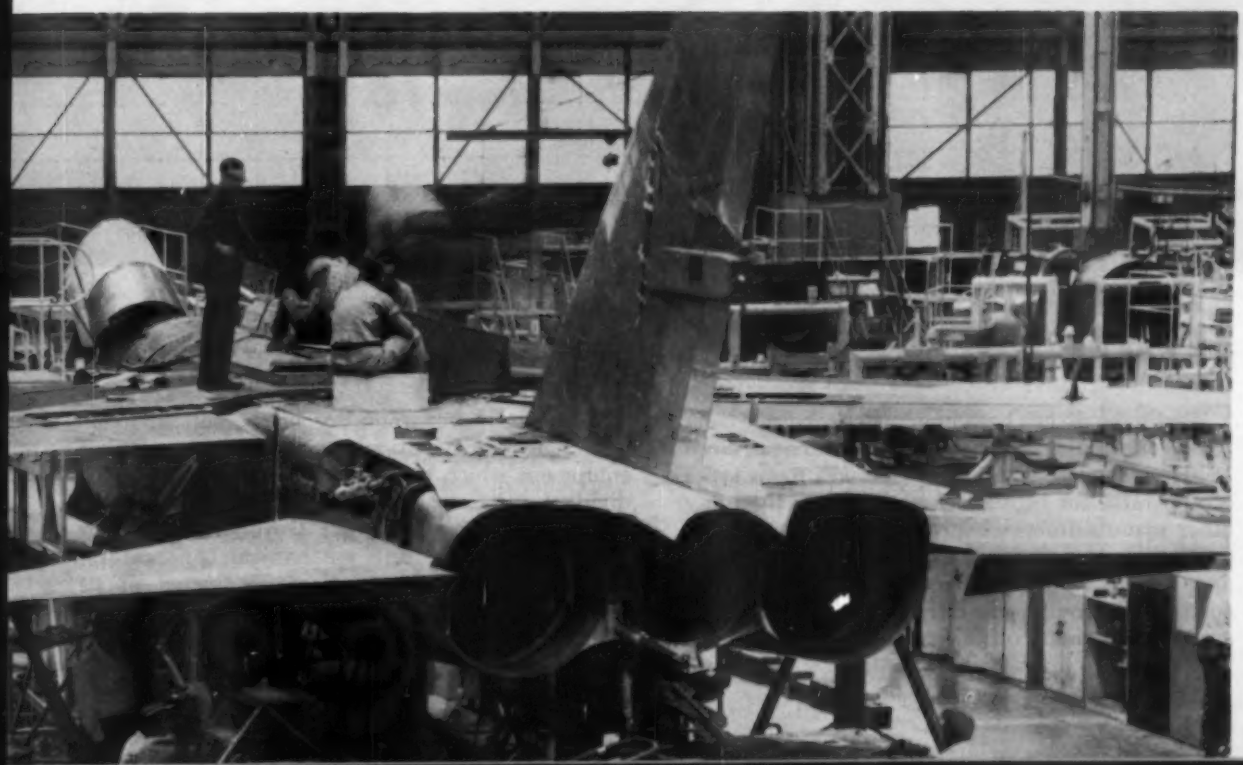
North American's Columbus Division Builds A3Js

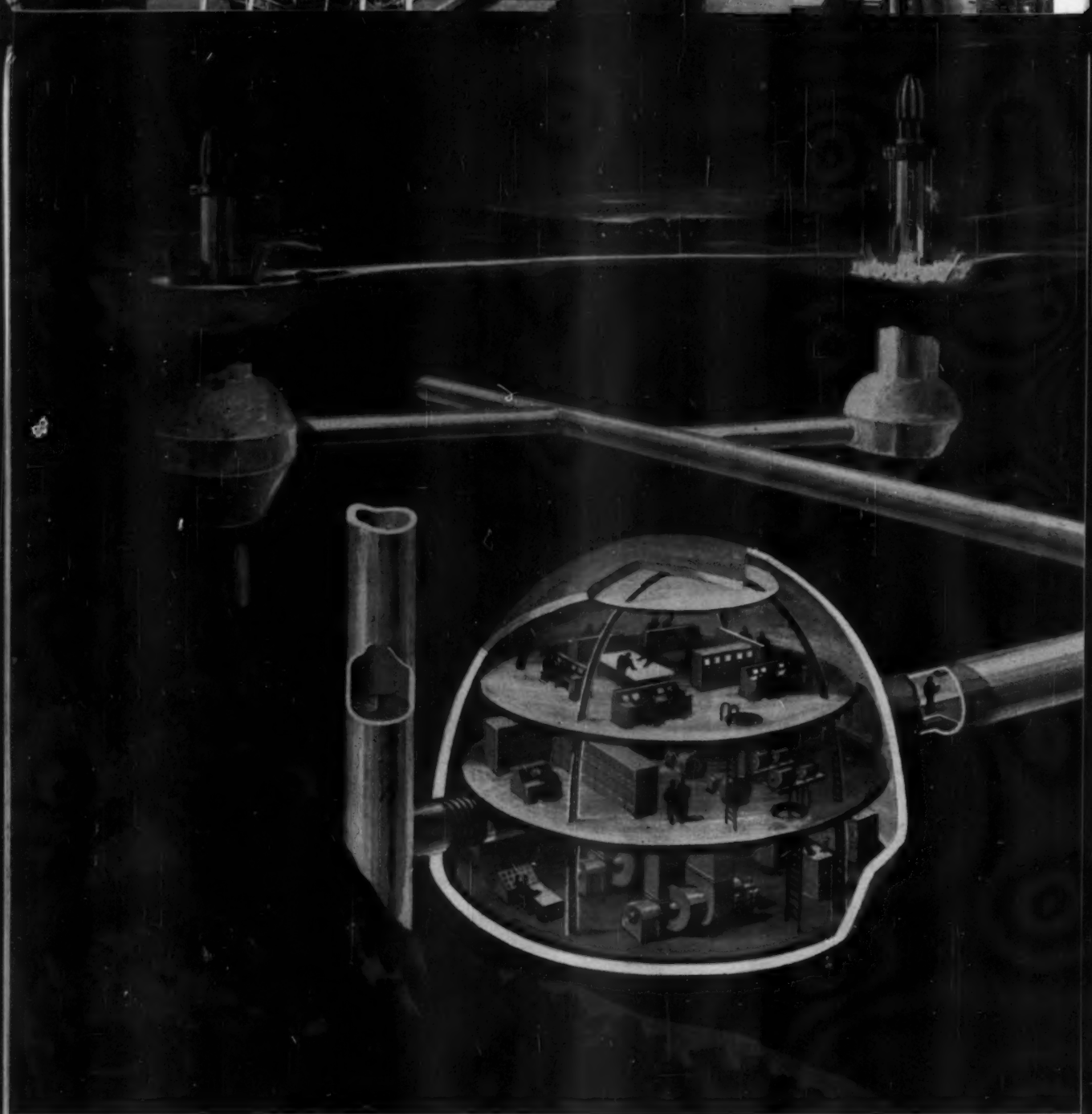
Fuselage of the A3J is of all-metal semi-monocoque construction. Vertical tail folds for stowage on Navy aircraft carrier.





Aft section of North American's A3J is fabricated in the final assembly area of the Columbus Division production line. Two General Electric J79 turbojet engines rated at 15,000 lb. thrust each power the A3J. Rearward-facing tube-like bomb bay is between the turbojet tailpipes. The Mach 2 attack bomber, capable of nuclear strikes, is scheduled to replace the Douglas A3D-2 in 1961 (AW Mar. 9, p. 81). Wing flaps, air brakes and landing gear are actuated by compressed nitrogen. The A3J will be lighter in weight than some of the attack aircraft now operating off Navy carriers. Engine air inlets are of variable geometry design for optimum performance at all speeds. Landing configuration incorporates droop leading edges and flaps and boundary layer control. Dimensions of the A3J are: length—70 ft., wing span—50 ft., height—20 ft. Aircraft has ejection seats fitted with integral folding fins for stabilization.





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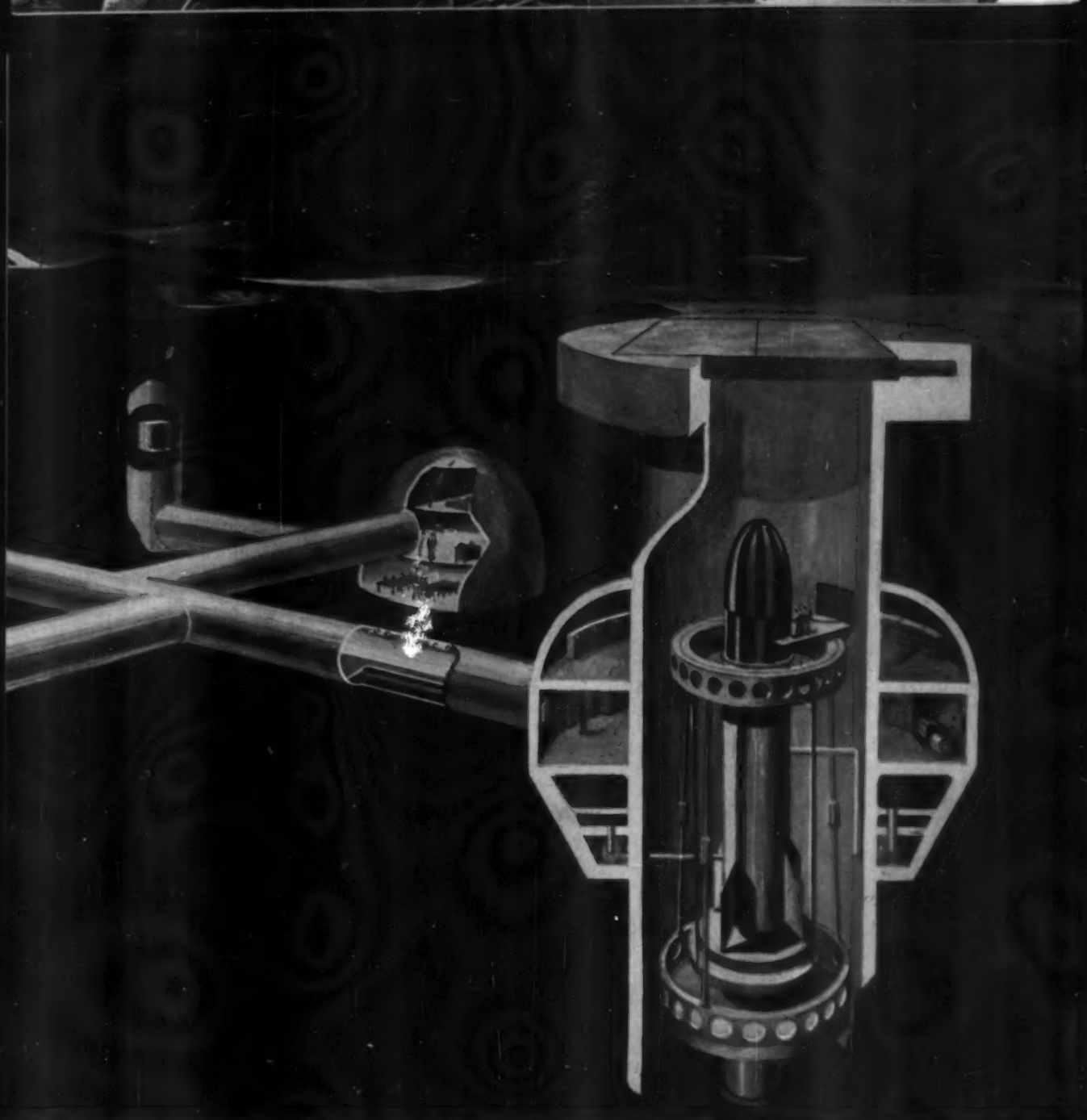

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Artist's conception of a possible hardened missile site, showing in blue some of the shock-proof equipment which Westinghouse can supply.

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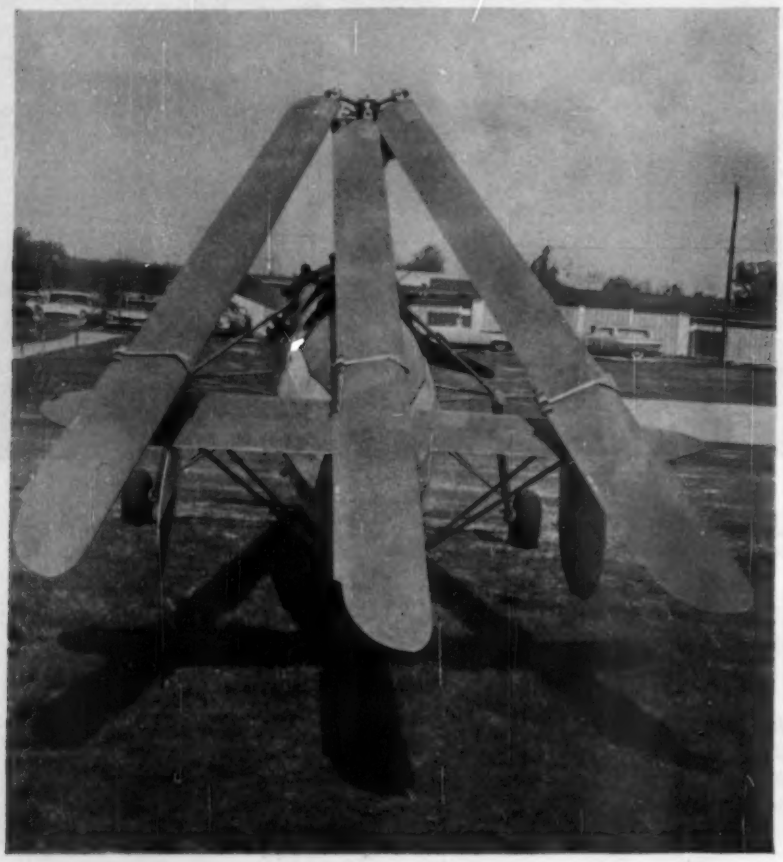
KD-1 Autogiro Enters Agricultural Market

PROTOTYPE KD-1A autogiro (above) demonstrates high degree of visibility offered by its wingless configuration. Aft fuselage fabric covering will be replaced by removable metal panels on production models. When three blades of 40-ft. rotor are folded, width is reduced to slightly over 10 ft. Agricultural version has 17-cu.-ft. hopper for chemicals.



Willow Grove, Pa.—An attempt to crack the agricultural aircraft market is being made by Kellett Aircraft Corp. here by reviving its pre-World War II KD-1A two-place autogiro, which has been rebuilt and recertificated in preparation for a production program.

Company officials report Kellett has 27 orders for its rotary wing aircraft, primarily from aerial applicators, and is now tooling up on a schedule that calls for rollout of the number one production KD-1B by the end of this year. Basic price, with a 225-hp. Jacobs radial engine, is quoted as $27,500.

KD-1B Modification

The KD-1B is a slightly modified version of the original KD-1A—among its changes will be replacement of fabric covering on the aft fuselage with quickly removable metal panels. Landing gear will also be revised to meet rough-field agricultural-type operations. Kellett is planning its production line on the basis of blocks of 50 aircraft at a run.

Useful load of the autogiro can be readily increased from the standard model's approximately 770 lb. to about 850 lb. if more powerful engines are used. The basic design is capable of taking powerplants up to approximately 350 hp. without requiring major structural modifications, company engineers state. Increased load and power would be favored by agricultural operators.

The KD-1B Cropmaster is designed to take a 17-cu.-ft.-capacity hopper located ahead of the cockpit.

Observation Model

Kellett's interest in reviving the autogiro also extends beyond the current Cropmaster: among its most active design projects is a two-place liaison-observation model, designated KD-10 powered by a 260-hp. fuel injection Continental O520 engine, which would have a top speed of 130 kt. and a cruise speed of 118 kt. This all-metal model would have jump takeoff characteristics: a low-power starting system would get the rotor up to approximately 300 rpm., enabling the aircraft to clear a 50-ft. obstacle only 50 ft. away. Use of this system would add some 60 lb. to the aircraft. Long life is seen for the system since it would only be used some 30 hr. out of 1,000 total autogiro operating hours, Kellett notes. The KD-10 would have four rotor blades compared with the three-blade system utilized on the Cropmaster.

Cropmaster and KD-10 programs are

MODEL of Kellett KD-10 liaison-observation aircraft, now in design stage, is shown in composite photo. Autogiro will be powered by a 260-hp. Continental O520 engine with fuel injection; designers also are considering use of a 250-hp. Allison T63 gas turbine powerplant.

entirely company-financed—no military contracts have yet been forthcoming although Kellett is attempting to interest the service in both versions. Primary interest has been shown by agricultural operators, who are attracted by its slow-speed characteristics—minimum speed is about 22 mph.—lack of complexity and ability to operate directly from the area it is spraying or dusting. Maneuverability is superior to fixed wing aircraft, making possible faster and more accurate dispersal of spray or dust chemicals; in addition the rotor, like that of a helicopter, tends to deflect the application directly downward.

The rotor is a free-wheeling system, dependent upon natural airflow over the blades to maintain rotation, and lift, in flight. Autorotation makes possible controllable engine-out landings in restricted areas. Since the system is not powered, hovering capability, like that of a helicopter, is not available. Kellett expects to capitalize on the autogiro's greater simplicity, providing lower maintenance cost and making possible use of conventional aircraft service personnel and techniques. The company expects to provide demonstrations later this month to groups interested in power line and pipe line inspection, photography and forest fire patrol.

Conventional stick and rudder pedal control makes it possible to check out any qualified fixed wing aircraft pilot on the autogiro in three hours.

Kellett Cropmaster

Rotor span	40 ft.
Length (blades folded)	26 ft.
Width	10 ft. 3 in.
Height	10 ft. 10 in.
Gross weight	2,200 lb.
Empty weight	1,500 lb.
Top speed	125 mph.
Minimum flight speed	22 mph.
Landing speed	0 mph.
Rate of climb	1,060 fpm.
Takeoff run (zero wind)	200 ft.
Service ceiling	14,000 ft.
Powerplant	1 Jacobs R755-9 225 hp.

PRIVATE LINES

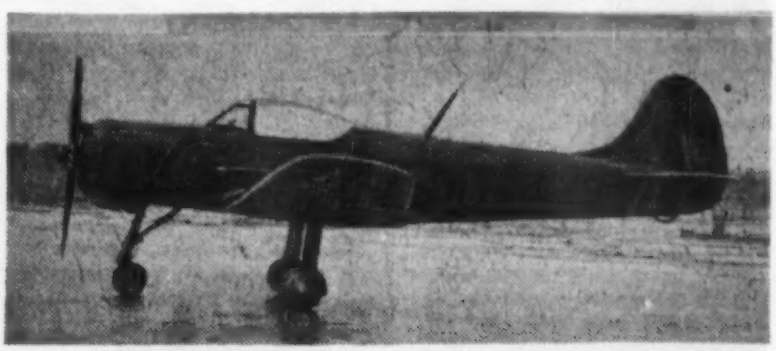
In report on Beech 18 modernization program (AW May 4, p. 163), powerplants were incorrectly referred to as Pratt & Whitney R1340s—they are properly Pratt & Whitney R985s.

Three Alouette II turbine-powered helicopters have been sold by Republic Aviation Corp.; one each to Ontario Hydro-Electric Commission of Canada, Dr. Hugh B. Fate, Alaska, and Petroleum Helicopters, Inc., La. Hydro-Electric Commission will use its Alouette primarily for spraying to inhibit weed growth along power line rights of way; Dr. Fate is leasing his aircraft to Northern Airways, Fairbanks, for forestry work, salvage, cargo and passenger hauls.

General Aircraft Supply, Detroit, has taken over management and operation of Central Aero Supply, Inc. and the combined operation has been merged with Airwork Corp. as a subsidiary. General is supplying management experience and additional product lines to the two bases formerly operated by Central; Airwork is contributing additional capital plus its complete line of exchange engines and engine-driven accessories. General expects its expanded territory to provide some $2.25 million of business in the first year of its new operation; sales of its Detroit operation increased 36% in the first quarter of 1959.

Utility aircraft, capable of carrying 1½-ton payloads of either passengers or cargo, is being designed by a new light aircraft division of Short Bros. & Harland, Ltd., Northern Ireland. Small-field capability is planned for new aircraft, designated Short SC-7.

Nine-day air tour, starting in Miami, Fla. and terminating at Fairbanks, Alaska, starts June 19th. Some 50 aircraft are already signed up for the air tour, according to 49'er Air Cruise Assn. President Harry B. Collins. Requirements include an airplane with at



First Photo of Yak-18A Soviet Trainer

New Yak-18A, being delivered to Soviet air force in substantial quantities, is a more powerful version of earlier models, which have been serving as military and civil aero club trainers since 1946. Two-place Yak-18A features installation of 260-hp. nine-cylinder radial AI-14R engines, providing top speed of 163 mph. and sea level rate of climb of 1,062 fpm. Earlier Yak-18 is powered by 160-hp. engine. Yak-18A's tricycle landing gear is semi-retractable; skis can be fitted in place of wheels. Another version, Yak-18P, has fully-retractable landing gear, top speed of 186 mph. and 1,575-fpm. rate of climb.

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least a 400-mi. range, 120-mph. cruise speed, and two-way radio, including low frequency receiver. Registration fee is $20 per airplane. Participants may join the cruise, honoring induction of Alaska as the 49th State in the Union, en route, providing advance notice is given. Further details are available from Harry B. Collins, Air Cruise Director, 375 N.E., 154th St., N. Miami Beach 62, Fla.

Air photo repository, to collect, store and reproduce vertical and oblique pictures for teaching and research programs, has been established at the University of Illinois. The library is collecting prints and negatives from all over the world, subject to recall by the depositors. Prints may be purchased through the library. As part of its interest in aerial photo work, the University's committee on aerial photography is handling a study of light reflectance from forest vegetation, under a $27,500 grant from the Office of Naval Research.

New model amphibian floats with hydraulic retraction system have been developed by Edo Corp. for Cessna 180-class utility planes. The actuating system replaces the former electrical type used on initial amphibious floats for the Model 180 placed on the market some five years ago. Floats currently have a hand-operated pump, requiring approximately 43 strokes for retraction process; an engine-driven pump with accessories will be offered in kit form later. New Model 439 floats also have improved type of shimmy damper.

Westinghouse Gets F-27 'Flying Office'

Custom interior designed and installed by Horton & Horton in Westinghouse Fairchild F-27 executive transport features sleeping compartment in rear of cabin, separated from forward section by drapes, shown fastened to sidewalls. Two sofas (foreground), convert to beds, weigh only 74 lb. each. All chairs in the airplane swivel 360 deg.; in addition the four just ahead of the sofas are tracked so they can be drawn together around a stowable conference table. Westinghouse Micarta mural on forward bulkhead duplicates that in the office of the company's board chairman, opens to provide access to the cockpit. Six cabin speakers are embedded in the vinyl shantung silk headlining.

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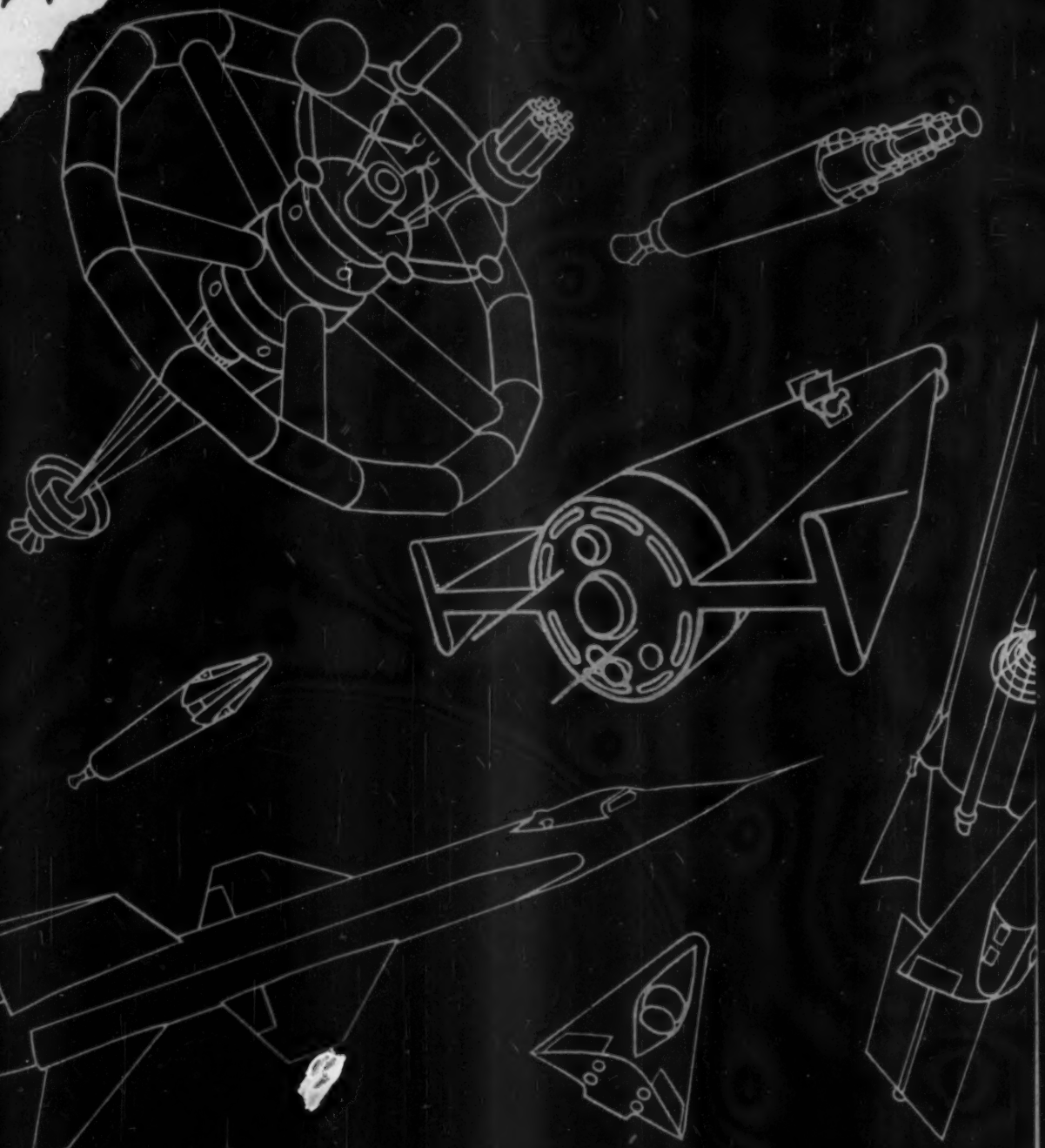

in space...
space exploration"

AVIATION WEEK's 1959 R&D issue will be titled, "The New Decade In Space —Blueprint for U. S. Space Exploration." This special report, the first of its kind to be presented, will plot the nation's space exploration for the next 10 years. A feature of the issue will be a 40-page illustrated editorial section published in insert form to meet the requirements of scientific, military and industry planners.

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Stepping up the pace of jet training...Cessna T-37

A firm foundation of an all-jet air force is an all-jet training program—and the U. S. Air Force is fast approaching that goal with Cessna's **T-37.** The high-altitude performance, high to low speeds, easy handling, and side-by-side seating of this twin-jet trainer permits a quicker, safer transition into combat jets. The big benefit: cadets learn faster while the Air Force achieves considerable savings in time and money. Cessna Aircraft Company, Wichita, Kansas.

Cessna

CAB Accident Investigation Report:

Overloading Linked to Mike Todd Crash

A Lockheed executive aircraft, en route from Burbank, Calif., to Tulsa, Okla., crashed and burned 12 mi. southwest of Grants, N. M., during darkness, the morning of Mar. 22, 1958. All four occupants were killed.

The flight had made routine position reports from its assigned altitude of 11,000 ft. until passing over Winslow, Ariz. Shortly after the last routine report at 11,000 ft. a higher altitude was requested of Air Traffic Control because of encountering icing conditions. The request was granted and the aircraft reported, five minutes later, being at 13,000 ft. between cloud layers. The last report was over Zuni, N. M., estimating Grants at 0249, 19 min. later. Ten minutes after this report a ground explosion at an elevation of 7,200 ft. msl. was observed by another flight and by ground witnesses. The wreckage of N 300E was found in the area of the witnessed explosion.

The right engine master rod bearing had failed in flight and the right propeller was feathered; however, complete loss of control followed and the aircraft struck the ground in a very steep angle of descent. As far as can be determined, there was no failure of the aircraft structure or controls prior to ground impact. The aircraft had anti-icing equipment installed and the pilots were experienced in Lodestar operation. There is evidence of the aircraft being considerably over its maximum allowable weight at departure and it is believed that the comparatively sudden failure of an engine at 13,000 ft. created a situation, made more critical by virtue of the then existing weight, in which the pilot was unable to maintain control of the aircraft.

INVESTIGATION

U. S. Weather Bureau forecasters at Burbank cannot recall briefing a flight to Tulsa the evening of Mar. 21. However, a briefing is not mandatory and the pilots of N 300E may have made their own analysis from the weather maps and charts which are displayed in the Weather Bureau office. At the time of departure a steady rain was falling and the freezing level, at Burbank, was 8,000 ft. On the planned route of N 300E moderate-to-severe turbulence was forecast at 5,000 ft. and above.

An instrument flight plan was filed with ARTC (Air Route Traffic Control) specifying flight at 11,000 ft., direct Burbank to Palmdale, Calif., airway Victor 12 Amarillo, Tex., airway Victor 140 to Tulsa, Okla.

The flight departed with two pilots and two passengers aboard, at 2241 PST, and position reports were made on schedule.

The flight progressed normally until 0157[1] when a report was made over Winslow, Ariz., at 11,000 ft., estimating Zuni, N. M., at 0226. At 0214 the flight gave Zuni radio this message: "N 300E, estimating Zuni at 28. At one one thousand encountering light-to-moderate icing of all types. Request one three thousand, believe I will be on top at one three thousand." A clearance to 13,000 ft. was issued by Albuquerque ARTC and delivered to the flight at 0215. At 0223 the flight reported: "N 300E reached one three thousand at two zero, now between layers." At 0231 the flight reported: "N 300E over Zuni at three zero, one three thousand, estimating Grants at four nine." This was the last known message from the aircraft.

An airline captain, whose flight was in the vicinity at the time, heard the pilot of N 300E accept the clearance to 13,000 ft. The captain stated there was no indication of apprehension or stress in the pilot's voice.

The scene of the accident was in a small valley between two mountains at an elevation of approximately 7,209 ft., 12 mi. southwest of Grants, N. M. The major portion of the wreckage was in or adjacent to the initial impact crater. The crater was approximately 25 ft. long (measured north to south), 12½ ft. wide (measured east to west), and 3½ ft deep.

The fuselage, center section, and empennage were completely destroyed by the severe impact and subsequent fire. The left and right wing panels outboard of their respective nacelles were found next to the impact crater in normal position relative to the remainder of the structure. Both wings were crushed chordwise. Wing flaps, still attached, were in the retracted position. The landing gear was also found in the retracted position.

Examination of the rudders, vertical fins, elevators, trim tabs, and horizontal stabilizers indicated that the empennage had been intact prior to ground impact.

No evidence of malfunction of the empennage or control therein was found. The control system forward of the empennage was so severely damaged by impact and fire that its condition prior to impact could not be determined. However, flight control cables were found to be properly attached to their respective terminals.

Examination of the two powerplants disclosed that the right propeller was in the feathered position at the time of impact. Disassembly of the right engine revealed a failed master rod bearing and several broken connecting rods. Examination of the left engine indicated normal operation prior to impact. A review of the last two 100-hr. inspections (Atlantic Aviation, Teterboro, N. J., Jan. 8, 1958, and Mattituck Air Base, Linden, N. J., Mar. 7, 1958) revealed no items inspected or corrected that have any connection with the master rod bearing failure in the right engine. The aircraft logs carried in N 300E were destroyed in the fire occurring after ground impact, except for a few burned pages.

There are two vacuum pumps on the Lockheed Lodestar (one on each engine) to operate the flight instruments (artificial horizon, directional gyro, and turn and bank). A right or left selector for these pumps is located on the lower right side of the instrument panel.

In case of an engine failure the selector must be positioned to the operating engine. It was not possible, because of impact and fire damage, to determine the position of the selector at the time of the crash. This fact also applies to the fuel selector positions.

The maximum certificated takeoff weight for Lockheed N 300E as revealed by the aircraft's documents and other sources was 18,605 lb. The aircraft was fueled to capacity (798 gal.) the evening of Mar. 21 at Lockheed Terminal. This amount of fuel was possible because of the use of two 77-gal. belly tanks in addition to the standard tank installation. It is not known if a weight and balance computation was made by the crew prior to departure.

The following weights are valid as all items listed are known to have been aboard. Miscellaneous items such as fresh water supply, buffet equipment, canned food, are not included as the actual quantities and weights are not known. Minimum takeoff weight for this flight is computed as follows:

Aircraft, empty weight (per ACA-337)[2]	14,566
De-icer boots	105
Fuel, 798 gal. @ 6 lb./gal.	4,788
Oil, 36 gal. @ 7.4 lb./gal.	266
Alcohol (anti-ice) 14.6 gal. @ 6.75 lb./gal.	98
Inverter for tape recorder	22
Spare tail wheel	20
Typewriter	12
Two pilots @ 170 lb.	340
Pilot Navigator kit and baggage @ 40 lb.	120
Two passengers @ 170 lb.	340
Passenger baggage @ 40 lb.	80
Total	20,757

Accordingly, N 300E was at least 2,152 lb. over the maximum certificated weight at the time of takeoff. Assuming a fuel burnoff, including climb, of 320 gal., three hours after takeoff the weight at the time of the crash was approximately 18,837 lb., or 232 lb. over maximum certificated weight.

The standard fuel capacity of Lockheed Lodestar, model 18-56, is 644 gal. divided among four tanks. In January, 1958, two additional tanks (77 gal. each) in the No. 4 baggage compartment were approved as a permanent installation by the CAA District Office, Teterboro, N. J.

Forms ACA-337, on file with the same CAA office, show the empty aircraft weight to be 14,566 lb. This weight plus a fuel load of 798 gal. produces a weight of 19,354 lb., or 749 lb. over the maximum allowable without pilots, passengers, baggage, or even

[1]All times herein are Mountain Standard, unless otherwise indicated, and are based on the 24-hr. clock; all altitudes are mean sea level.

[2]ACA-337 is a Civil Aeronautics form required when there is major repair and alteration (airframe, powerplant, propeller, or appliance). It is executed by the repair station and approved by a CAA agent.

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the other incidental aircraft or engine supplies. The Board received testimony concerning several transcontinental trips where the full fuel capacity was utilized. The overload of 2,152 lb. that existed at the time of the takeoff from Burbank on Mar. 21, 1958, was not an isolated overload incident.

Flight test data (Spec. No. A-723) compiled by the Civil Aeronautics Administration indicates the single-engine ceiling of the Lockheed, model 18-56, to be 13,350 ft. at a weight of 18,500 lb.

A multicentered low pressure area extended from the Plains States westward to the Pacific coast. One low pressure center was drifting slowly eastward through the Texas Panhandle.

A weak occluded front extended southwestward through western Texas and northern Mexico to a shallow wave near San Diego, Calif.

Upper air charts (700 and 500 millibar levels) showed pronounced low pressure centers over southern New England and off the Pacific coast with no pronounced ridges or troughs in the Southwestern States.

On the night of Mar. 21 along the route between Prescott, Ariz., and Grants, N. M., (a) the freezing level was approximately 10,000 ft., (b) winds at the 10,000- to 15,000-ft. level were generally from 230 to 270 deg. at 30 to 40 kt., (c) ceilings after midnight and prior to 0300 were mostly 3,000 to 5,000 ft. lowering occasionally to 1,500 ft. to 2,500 ft. in light rain, (d) surface visibilities were 10 mi. or better, (e) Grants, N. M., at the time of the accident was reporting clear skies and visibility 30 mi. with a cloud bank to the west, (f) Zuni, N. M., at this same time reported a broken ceiling measured at 1,500 ft. with an overcast above, based at 2,500 ft. and a visibility of 10 mi. in very light rain, (g) radiosonde observations indicated a possible top to the lower cloud decks at 12,000 ft. Visibilities were greater east of Grants. The pilot of an Air Force B-36, at 20,000 ft., 30 mi. south of Albuquerque, reported seeing an explosion at 0240 on the surface between Zuni and Grants.

An employe of the CAA at the Grants communications station reported to Albuquerque ARTC Center that at 0240 he had observed what appeared to be a surface explosion southwest of the Grants station. This agrees with the observation of the Air Force witness and the actual location of the wreckage of N 300E.

Lockheed Lodestar N 300E, owned and operated by Ayer Lease Plan, Inc., of Linden, N. J., had been leased to the Michael Todd Company, Inc., of New York, N. Y., in October, 1957. Pilot William Verner had been assigned to the aircraft since that time and had made numerous trips, including two cross-Atlantic flights and a tour of Europe. Both Mr. Verner and Mr. Barclay, the copilot, held airline transport ratings and were qualified and experienced on Lockheed Lodestar aircraft. The purpose of the flight which was terminated by the accident, was to transport Mr. Todd and his associate, Mr. Arthur Cohn from Burbank, Calif., to New York City via Tulsa, Okla.

The Board was notified of a Lockheed Lodestar, operated by a major oil company, encountering icing conditions on Feb. 28, 1958, during a flight from Denver, Colo., to Chicago, Ill. This aircraft experienced

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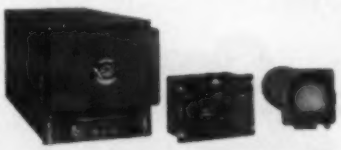

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an unusual ice accretion on both pitot masts, located on the forward underside of the fuselage, that produced a serious underreading and fluctuation on both the pilot's and copilot's air speed indicators, leading the pilot to believe he was at or near a stalled condition, when in reality the aircraft was flying well above the stall speed. In this incident the pilot was able to maintain control and descend to clear conditions through the exclusive use of the vacuum operated flight instruments. This aircraft did not have an alternate source for the static system by reason of modification.

With regard to N 300E the manufacturer has advised the Board that all aircraft of the type (USAF C-60, U. S. Navy R-50-5, civil type 18-56) were originally equipped with an alternate source for the static system. A careful examination of all the Forms ACA-337 on file with the Civil Aeronautics Administration failed to reveal an elimination of the alternate source. The forms do indicate the installation of dual pitot masts on the underside of the fuselage below the cockpit. This installation is the same as that on the aircraft encountering icing affecting the pitot static systems. N 300E was delivered to the U. S. Navy as a model 50-5 Lockheed.

ANALYSIS

On that portion of the route through central Arizona and western New Mexico, all evidence indicates that the flight would have encountered extensive cloudiness, numerous shower areas, and moderate icing in clouds, and precipitation above 10,000 ft.

Fifteen minutes before reaching Zuni, N. M., the flight had added two minutes to its Zuni estimate, advised that it was encountering moderate icing at 11,000 ft. and requested clearance to 13,000. Clearance was granted and the flight subsequently reported (0223) at 13,000 ft. between layers.

It was raining at Zuni, N. M., when the flight passed overhead at 0230 and Grants, N. M., was reporting a cloud bank to the west. These weather observations, combined with testimony of ground and air witnesses describing the ground explosion associated with the accident, indicate that the accident site was located at the eastern edge of the bad weather area.

On the basis of the foregoing, it is apparent that icing conditions had been encountered by the flight, necessitating a change of altitude. A climb of 2,000 ft. carried the aircraft between cloud layers and the use of boot-type de-icing equipment partially alleviated the icing difficulty. In view of continued passage through below freezing temperatures, residual ice not discharged by the boots was retained on the aircraft. Furthermore, passage through a precipitation area over Zuni immediately prior to the crash may have added some additional ice.

Such icing would have had an adverse effect upon the single-engine performance capability of this heavily loaded airplane which was near its usable ceiling.

When operating on single-engine at or near the single-engine ceiling, at maximum weight, a stall and loss of control can easily occur. This requires increased vigilance on the part of the pilot to maintain

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the proper aircraft attitude and airspeed. Had the aircraft departed Burbank at its permissible weight of 18,605 lb. the weight, because of fuel consumed, would have been approximately 16,500 lb., or about 2,000 lb. less than its actual weight at the time of the accident. Consequently, stalling speed of the aircraft would have been lower at the time of the emergency.

It appears that this accident was in the pattern of other accidents investigated by the Board where an aircraft overload was either the primary cause or a major contributing factor in the accident.

It is pertinent to point out that N 300E, when fueled to the capacity of its four standard tanks and with a normal oil supply, would have exceeded its certificated allowable weight by 91 lb. without a flight crew or payload. The full use of the two additional 77-gal. baggage compartment tanks under the above conditions would add 924 lb. of fuel weight to the already existing overload. Although this aircraft had been operated in the past at weights in excess of the maximum certificated weight pursuant to a flight permit issued by the Administrator, no waiver of the certification weight limits was issued for the flight of Mar. 22 and 23, 1958, a flight on which passengers were carried.

CONCLUSIONS

The Civil Air Regulations prohibit the operation of a civil aircraft at a gross operating weight in excess of the maximum authorized by the certificating authority. This aircraft (N 300E) was overloaded when the engine failure occurred en route which was followed by a stall and loss of control at the 13,000-ft. altitude. There is no doubt that control was lost as evidenced by impact markings on the ground.

The pilot of a civil aircraft is charged with having knowledge of the provisions of the Civil Air Regulations and has the responsibility of determining that his aircraft when loaded does not exceed the gross weight and center of gravity limits prescribed for it. As previously stated, both of the pilots possessed airline transport ratings and were well qualified in Lodestar aircraft. In this instance, the pilot ordered and supervised the full fueling of the aircraft; it is inconceivable that he was not aware of the overloaded condition.

This entire matter has been brought to the attention of the Administrator of the Federal Aviation Agency by the Board with a recommendation that consideration be given to the development of adequate safeguards to prevent overloading under circumstances such as those involved in this accident.

Ice accretion on the aircraft surfaces undoubtedly increased the weight of the already overloaded aircraft and adversely affected its flight characteristics. With icing conditions in existence and the wing deicing boots in operation at the time of the engine failure, control of the aircraft would have been rendered even more critical.

The Board also believes that the sudden engine failure and the necessary immediate initiation of single-engine procedures distracted the pilot's attention from the flight instruments sufficiently to result in loss of control of the aircraft and the 5,800-ft. terrain clearance was insufficient to permit recovery by instrument reference.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the loss of control of an overloaded aircraft following the failure of an engine at a cruising altitude which was critical for single-engine operation. The loss of control was aggravated by surface ice accretion.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of the accident the morning of Mar. 22, 1958. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions were taken at Linden, N. J., on July 10, 1958, and at Santa Monica and Burbank, Calif., on July 30 and 31, 1958.

Lockheed Lodestar, N 300E, was owned by Ayer Lease Plan, Inc., Linden Airport, N. J. The aircraft had been on lease to movie producer Michael Todd since October, 1957. Ayer Lease Plan, Inc., is a lessor of executive type aircraft and owns many types of aircraft. Pilot personnel in this instance for the operation of the leased aircraft was provided by the Linden Flight Service, Inc., Linden Airport, N. J.

FLIGHT PERSONNEL

William Stebbins Verner, 42 years old, held a currently effective airman certificate with ratings of airline transport and flight instructor. He had been employed by Linden Flight Service, Inc., since April 22, 1957. His total pilot time was 7,680 hr., of which 386 were in Lockheed Lodestars. His last physical examination was passed, no waivers, on Jan. 14, 1958.

Thomas Barclay, age 36, was employed by Linden Flight Service, Inc., in December, 1957. He held a currently effective airman certificate with ratings of airline transport and flight instructor, and airplane and engine mechanic. Company records indicate a total pilot time of 4,500 hr., of which 3,500 were in multi-engine equipment. His last physical examination was passed on May 9, 1957, with no waivers. Mr. Barclay was assigned as copilot and mechanic on N 300E.

THE AIRCRAFT

Lockheed Lodestar, model 18-56, serial number 2312, was owned and operated by Ayer Lease Plan, Inc., Linden Airport, Linden, N. J. Total time on the aircraft was 3,910 hr. with 54¼ hr. since the last 100-hr. inspection on Mar. 7, 1958. The aircraft was equipped with two Wright model 1820-56A engines and the propellers were Hamilton Standard, model 23E50, with 6339A-12 blades. Total time on the No. 1 and No. 2 engines was 703 hr. and 449 hr., respectively. N 300E had not been modified to permit the use of takeoff power in excess of 1,200 hp. per engine.

WHO'S WHERE

(Continued from page 23)

Honors and Elections

First Lieutenant James E. Obenauf, USAF pilot, has received the Aviators' Post Valor Award for his actions in saving a burning B-47 bomber and the life of the disabled instructor-navigator after an in-flight explosion April 28, 1958.

Karel J. Bossart, of Convair Division of General Dynamics Corp., has received the California Air Force Assn.'s Man of the Year in Science Award "in recognition of the culmination of many years of determined effort to create a successful ICBM for the United States."

The Geophysics Research Directorate, Air Force Cambridge Research Center, has selected **Dr. Norman A. Haskell** as the Guenter Loeser Memorial Lecturer for 1959.

Earl D. Johnson, president of General Dynamics Corp., has been elected president of The Wings Club, New York, N. Y.

Dr. Clifford Furnas has been appointed vice chairman of the Army Scientific Advisory Panel.

Changes

Richard W. Sweeney, assistant manager-market development for aircraft and missiles, Mallory-Sharon Metals Corp., Niles, Ohio.

Carl E. Swanson, field service representative for Grumman Aircraft Engineering Corp. at Southwest Automotive Co., Dallas, Tex.

Ramo-Wooldridge Division of Thompson Ramo Wooldridge, Inc., Los Angeles, Calif., has reorganized its engineering facility into two major operating divisions and made the following appointments: **T. B. Bissett,** director, and **Bernard Berman,** associate director, of the newly designated Systems Technology Division; **Milton E. Mohr,** acting director, of the Data Processing Division. Data Processing also includes a Machine Translation group, headed by **Dr. D. R. Swanson,** and a Display Techniques group, under **Donald W. Pugsley.**

Kenneth M. Miller, general manager, LearCal Division of Lear, Inc., Santa Monica, Calif. Mr. Miller succeeds **Edward F. Conklin** who is now assistant to the board chairman.

David E. Shonerd, assistant program director-Minuteman program, Space Technology Laboratories, Inc., Los Angeles, Calif.

David E. Postle, head-Commercial Sales Division, Kaman Aircraft Corp., Bloomfield, Conn. Mr. Postle will concentrate on Fairey Rotodyne sales.

Stanley W. Smith, chief engineer, Aircraft and Missiles Division, Fairchild Engine & Airplane Corp., Hagerstown, Md.

Rolland E. Erbentraut, manager, Field Engineering Division, Sperry Gyroscope Co., Great Neck, N. Y. Also: **Stuart G. Farnum,** sales manager.

Webster A. Jones, corporate assistant director of public relations, Rheem Manufacturing Co., Los Angeles, Calif.

David H. Newby, the National Aeronautics and Space Administration's representative at the Army Ordnance Missile Command, Huntsville, Ala.

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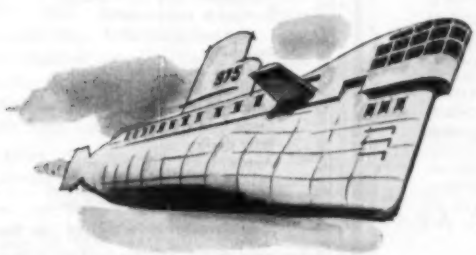

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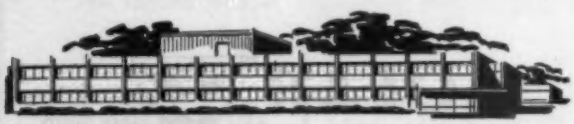

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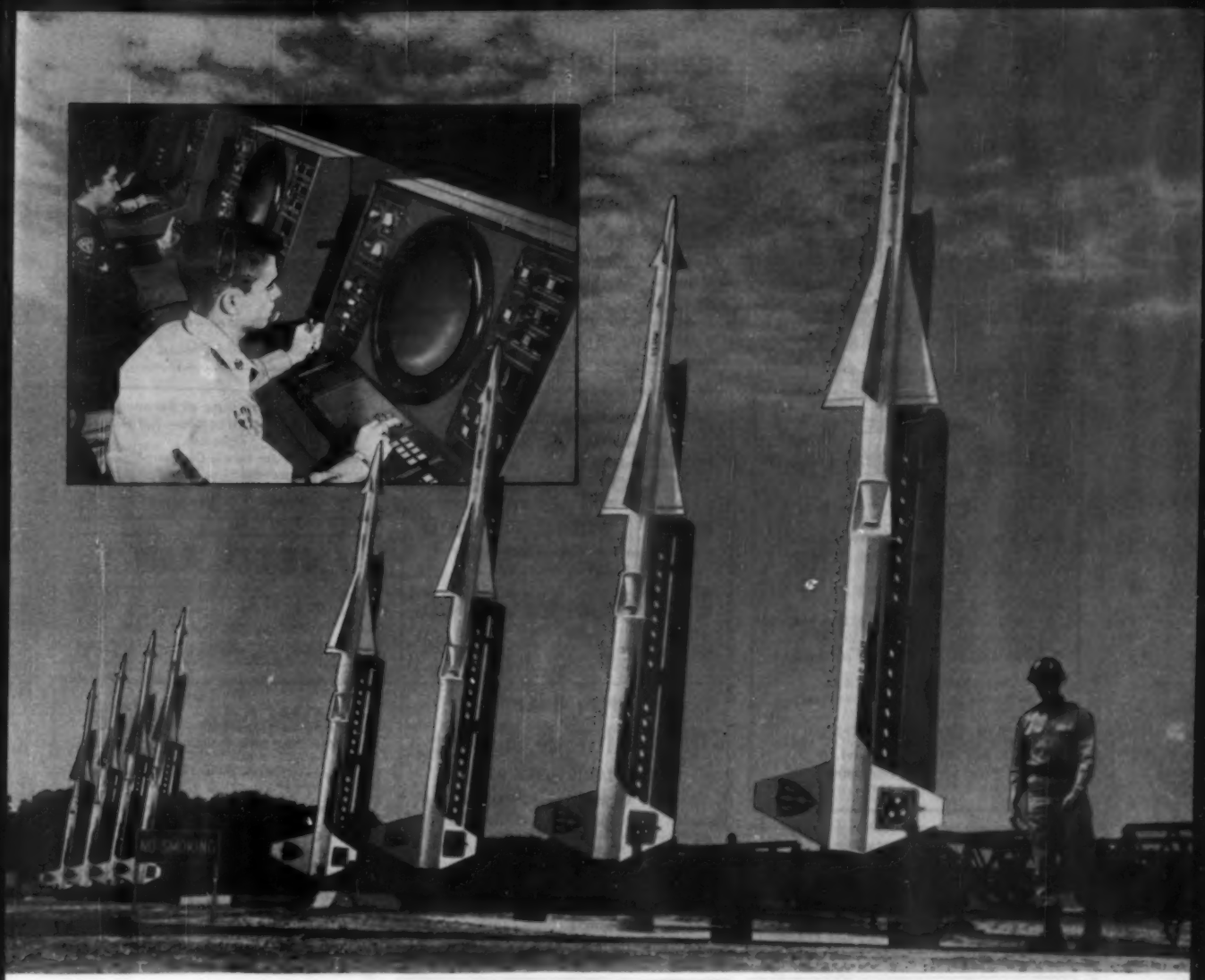

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LETTERS

Man in Space

I have been reading your magazine for several years and am grateful to see you print the facts as you see them, not as we would like to see them.

I see frequent mention of the Mercury Man-in-Space project. I doubt if we are ready to try this gamble with a man's life. His chances of returning alive are probably one in a hundred; his chances of being found even if he lands alive are compounded to the order of one in ten thousand.

Have we the right to ask a man to take this chance? Remember the hue and cry about a dog in space. What would it be if we got a man into orbit and could not get him down? So much pressure would be brought to bear on Congress that we would lose our whole space program. Are we ready for this gamble?

Let us wait until the science of rocketry advances enough to be reasonably sure of his return. Let the Russians try it, as they will. We can use our technical knowledge to gather the information we need without jeopardizing a man's life.

William B. Albrecht
Vice President
Super Steel Products Co.
Milwaukee, Wisc.

(All seven Project Mercury pilots are volunteers.—Ed.)

Pilot Proficiency

The reader response to your Feb. 16 editorial, "Rewards and Responsibility," was somewhat disappointing. I anticipated some cheers, but I fully expected a more eloquent rebuttal from the pilot group than has been in evidence on your Letters page.

After taking a sober look at Capt. Sheehan's comments (AW Mar. 16, p. 122), I would hope that this is not representative of our airline pilots' attitude. First of all, the criticism of your "irresponsible language and facts" seems unwarranted. I don't know where the press release regarding the results of the CAA check of Northeast pilots came from, but since only the CAA and NEA were involved it must have come from the CAA; it certainly would not be the sort of publicity that NEA would consider appropriate. So much for the "irresponsible" facts!

With due respect for Check Pilot Sheehan's concept of the periodic pilot check being a "relative thing," there are many pilots among us who share the airways with Capt. Sheehan, and who pay airline fares for ourselves and our loved ones, who do not believe in the "relative" concept. We hope that the pilot check is somewhat more positive! In checking a pilot's ability, or more accurately a pilot's current proficiency, there is a standard that must be met. The standard is set forth by law and usually improved by the individual airline. The pilot should either meet the standard or be grounded until proficiency can be brought up to the standard. To my knowledge, at least one airline maintains and enforces this policy.

It is a poor offering to say that only four of the nine NEA pilots needed further training. In my book there is not room for even one airline pilot to be flying if his current proficiency is questionable.

The CAA unofficial report mentioned in Capt. Sheehan's letter is shocking! If true, it is an indictment of the FAA, the airline managements, and the pilots themselves, for if there were nine, or even only four, found deficient in a group with such a high average proficiency, how many would be found in the industry?

I would like to document my experience with Northeast Airlines in this area. Shortly following the NEA announcement of plans to begin service with DC-6s, I had a short talk with NEA's chief pilot at that time, in which I suggested the advantages of using professional instructors and check pilots as successfully used by several of the major carriers. I was firmly informed that NEA had plenty of men qualified for the work on the heavier equipment. The subsequent Rikers Island tragedy and the results of the more recent CAA checks would somehow lead me to believe that he was overly optimistic.

In the same general area, but another company: In the fall of 1957, the management of Eastern Air Lines in the interest of economy, greater safety, efficiency, and improved pilot proficiency, proposed the inauguration of a pilot check-training program using full time professional instructors and check pilots. The company withdrew the proposal following stormy sessions with the local pilots' council at which the plan was threatened with sabotage.

In my limited knowledge of the situation, it would appear that there is ample justification for the portion of your editorial pointing up greater discharge of responsibility by some of the airline pilots—Capt. Sheehan's indignation notwithstanding!

On the other hand, I think that your emphasis on "top pay . . . $33,600 . . ." and ". . . yields up to $40,000 . . ." in reference to airline pilots' compensation, is unfair. Few pilots are going to make these top figures. This is the treatment of the pilot by those outside the industry, many of whom somehow feel that the pilot is highly overpaid. It seems to me that the pilot group, if not admired, should at least be respected for their success in gaining for themselves not "lucrative rewards," as you term them, but a compensation commensurate with ever increasing responsibilities and our ever increasing cost of living.

Your indictment of the pilot tendency toward spare time commercial enterprise is also unfair. While there is no defense for the pilot who allows his extracurricular activities, commercial or otherwise, to interfere with his professional proficiency, I have a deep regard for the man who has the American initiative to develop other fields of enterprise. In some cases these efforts have even worked to advantage for the aviation industry. Witness Capt. Jeppesen and his Airway Manual Services.

By the same token, you point up the fact that the question of pilot age and physical standards is bound to become more acute with the jet age. As long as a pilot's security is bound by the thin string of physical fitness, and as long as a pilot's experience prepares him so little for so few other occupations, either before or after retirement age, it is unfair to criticize the pilot's outside enterprise.

It is true that airline pilots' compensation is based on 80 hr. monthly. However, those in the industry are well aware that the airline pilot spends considerably more time performing the duties of his occupation. As long as he maintains his proficiency, let his leisure time be his own.

Pan American Pilot
Miami, Fla.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

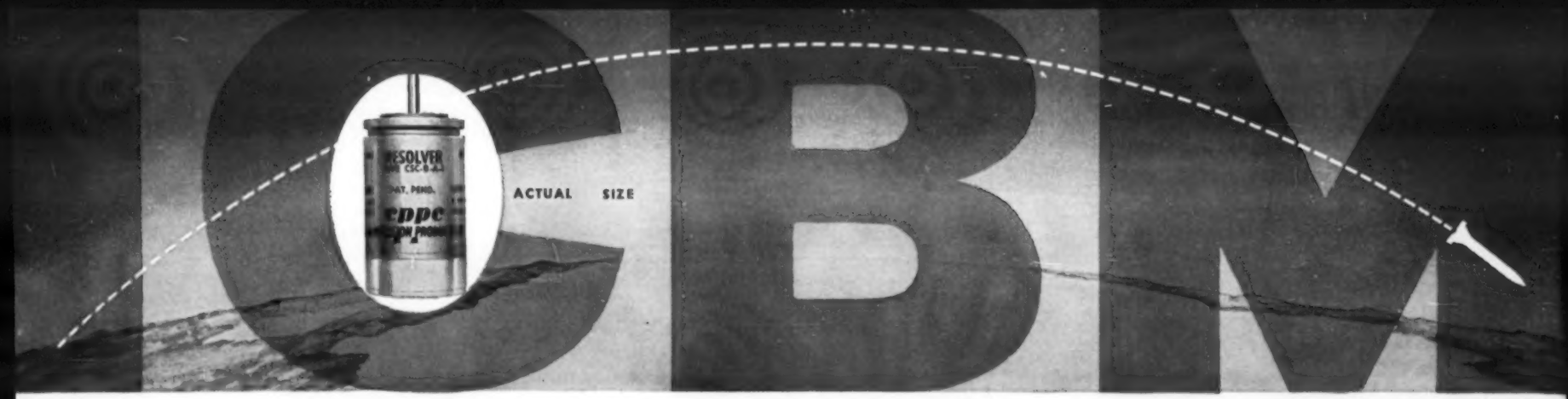
Average Pilot Age

To satisfy my own curiosity, I have just gone back through all the accident reports that were still in my files to see what the average age of the captains would be. The average of these 10 random reports, going back approximately two years, is 39. A further check of these records might indicate a somewhat higher average—or lower. I would venture to say that this is very near the average age of all airline captains. Now, if Mr. Kimmel (AW Feb. 23, p. 142) is going to fire, retire, or refuse to promote all the captains above this age, he is going to put the airlines out of business very quickly. Also, he has obviously never had the experience of making a low visibility back course approach at LaGuardia if he thinks it is sweat-free flying. It is somewhat like turning off your headlights when driving along a country road on a dark night.

Most of the airlines have literally spared no expense in setting up pilot training and evaluation programs and procedures aimed at producing and maintaining the highest possible level of piloting skill. Flight simulators in use today cost the airlines more than the airplanes themselves a few years ago. Thousands of dollars are being spent on aeromedical research in a constant attempt to learn more about human behavior. And much progress is being made, as the records will prove.

There is still no substitute for experience, particularly when it comes to flying. A captain who keeps himself physically fit and mentally alert is the best man to have in the cockpit regardless of age. His judgment is better and he is not as likely to place his aircraft in a potentially dangerous position. This is not to say that he cannot make a mistake. He is still a human being. But until such time that someone produces a robot with unfailing judgment and reaction, the trained pilot will continue to do the best job he can, limited only by the tools he is given to work with and occasionally his own human failings.

William P. Ellis
Cuyahoga Falls, Ohio



When Minutes (of error) Mean Miles "off target" specify Clifton Precision Size 8 Synchros

for

HIGHEST ACCURACY

SYNCHRO FUNCTION	CPPC TYPE	ROTOR AS PRIMARY						STATOR AS PRIMARY						D.C. RESISTANCE		IMPEDANCE			Max. Null Voltage (MV)	Max. Error (Min.)
		Input Voltage (400 ~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	Input Voltage (400 ~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	Phase Shift (deg. lead)	Rotor (Ohms)	Stator (Ohms)	Zro (Ohms)	Zio (Ohms)	Zso (Ohms)		
Torque Transmitter	CGC-8-A-7	26	100	.54	11.8	206	8.5	–	–	–	–	–	–	37	12	54 + j260	12 + j45	80 + j20	30	7
Control Transformer	CTC-8-A-1	–	–	–	–	–	–	11.8	.087	.21	23.5	411	9	143	24	210 + j690	28 + j114	250 + j73	30	7
Control Transformer	CTC-8-A-4	–	–	–	–	–	–	11.8	.030	.073	22.5	393	8.5	365	64	470 + j1770	81 + j330	590 + j190	30	7
Torque Receiver	CRC-8-A-1	26	100	.54	11.8	206	8.5	–	–	–	–	–	–	37	12	54 + j260	12 + j45	80 + j20	–	30 up.
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	11.8	.080	.25	23.5	411	11	230	27	270 + j630	39 + j142	340 + j67	30	7
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	20	26	.030	.23	21.5	376	12	230	170	270 + j630	250 + j830	340 + j67	30	7
Torque Differential	CDC-8-A-1	–	–	–	–	–	–	11.8	.087	.21	11.5	204	9	36	24	38 + j122	28 + j114	47 + j13	30	7
Vector Resolver	CVC-8-A-1	26	100	.54	11.8	206	8.5	–	–	–	–	–	–	37	16.5	54 + j260	19 + j60	80 + j20	30	7

Write for catalogue containing additional size 8 units.

ENGINEERS: Join a leader in the field of synchros and computers. Write David D. Brown, Personnel Director, Dept. A5.

CPPC FOR ANY ROTARY COMPONENT

CLIFTON PRECISION PRODUCTS CO., INC.

Sales Dept.: 9014 W. Chester Pike, Upper Darby, Pa.—Hilltop 9-1200

cppc

Clifton Heights, Pa.

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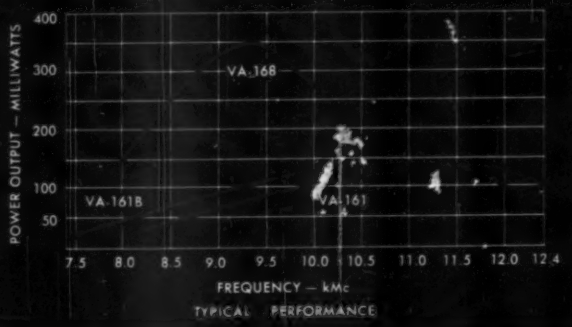

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